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The Need for a New Biophilosophy[1]

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Alfred North Whitehead is often regarded as the most original innovator of 20th century philosophy of nature and metaphysics. In recent decades a number of leading theoretical physicists have introduced ground-breaking new perspectives on fundamental issues of physics on the basis of his process philosophy. In contrast most biologists have not seriously questioned the Cartesian metaphysics of 19th century classical physics and only just begun thinking about possibilities of overcoming it. This book aims to contribute to the foundation of a new direction in biophilosophy which goes beyond many of the core metaphysical assumptions of contemporary mainstream biology. All of the co-authors of this volume treat central metaphysical questions about the nature of life from the perspective of Whitehead's process philosophy. These questions are crucial for the biosciences, but cannot be addressed by them since they touch on metaphysical issues.

In order to show the plausibility and the sense of this enterprise, first I will explain why I believe it is necessary to differentiate between biophilosophy and the philosophy of biology. Second I will review some of the shortcomings of today's biology and philosophy of biology and demonstrate how a biophilosophy grounded in a process-oriented metaphysics can overcome them. Third, I will provide a summary of Whitehead's process ontology, emphasizing those fundamental ideas from this paradigm that play essential roles in the present book. Finally, I will briefly describe the main ideas presented in subsequent chapters.

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1. Biophilosophy and Philosophy of Biology

Philosophy of biology is a discipline which was founded in the early 1970s by the efforts of Michael Ruse (1973) and David Hull (1974), but which had also had some precursors (Beckner 1959). The best-known representatives of this discipline, which has become especially established in the Anglo-American world, are theoretical biologists and philosophers.[2] Many authors also refer to the philosophy of biology as "biophilosophy". However, I do not think that these two labels should be used synonymously. I describe "biophilosophy" as a philosophic tradition existing since antiquity which includes a set of very different, heterogeneous philosophic considerations of life. From this point of view, philosophers of biology constitute only one subgroup within the broader category of biophilosophy, even though they are arguably the most influential group today.

There are two reasons why I suggest making this distinction between biophilosophy and philosophy of biology and consider the latter to be included in the former: First, considering biophilosophy to be the metaphysically more broadly conceived field allows one to point to the relevance of the works of philosophers like Aristotle and Kant to current biosciences without characterizing them as "philosophers of biology", which could be somewhat misleading given that the term "biology" was only introduced at the beginning of the 19th century when this discipline was founded. Second, in contrast to most scholars who understand themselves as philosophers of biology, and who, in their reflections about matter and causality, almost never contravene the basic metaphysical framework dictated by today's mainstream biology, the philosophical presuppositions of the biophilosophers follow very different metaphysical systems. This being said, however, it is important to note that the borders between both fields are fluid

The most important Western thinkers of biophilosophy who will remain relevant in its future are Aristotle and Kant. Other philosophers and

[2] Some of the most influential contributions to philosophy of biology have been provided by Francisco Ayala, Theodosius Dobzhansky, John Dupré, Steven Gould, Paul Griffiths, Richard Lewontin, Huberto Maturana, Ernst Mayr, Susan Oyama, Alexander Rosenberg, Elliott Sober, Kim Sterelny, and Francisco Varela.

scientists with considerable influence on biophilosophy are William Harvey, Gottfried Wilhelm Leibniz, Wolfgang von Goethe, Carl Gustav Carus, Gustav Theodor Fechner, Charles Darwin, Ernst Haeckel, Friedrich Nietzsche, Henri Bergson, Hans Driesch, Alfred North Whitehead, Charles Sanders Peirce, Jakob von Uexküll, Kurt Goldstein, Georges Canguilhem, Viktor von Weizsäcker, Adolf Portmann, Hans Jonas, Michel Foucault, and Gilles Deleuze. Recently, many contemporary bioscientists have provided new conceptions of organism, evolution, and consciousness which clearly transcend the frame of mainstream philosophy of biology.[3]

All forms of biophilosophy, including philosophy of biology, deal with questions that arise out of biology but which biology cannot answer. The central question revolves around our understanding of the concept of "life" – its meaning or semantic extension. In 20th century biophilosophy, this concept has a wide spectrum of connotations. On one level, "life" refers to the totality of processes which occur in any given physical entity that is described as an "organism". On another level, this concept refers to sets of such entities. So "life" often refers to a group of organisms of the same species (e.g., an animal colony) or to the interacting species of an ecosystem or even to the entire biosphere. Frequently "life" means all organisms which have come into being since the appearance of the first cell on the early earth, with some bioethicists even using this concept to refer to all future organisms. Sometimes the concept of "life" also includes hypothetical biological developments which could occur outside of the earth (exobiology), thus going beyond the spatiotemporal limits of evolution on earth. These different facets of the term "life" are present in virtually all of the forms of contemporary biophilosophy. The only really controversial question is whether real or potentially real products of the "Artificial Life" (AL) project, i.e., computer simulations of organisms and ecosytems (e.g. Tierra or Daisyworld), "intelligent" robots, or future self-reproducing automata (which would be physical entities rather than computer simulations), should be included in the category of "life". Proponents of the so-called "strong AL" follow John von Neumann's position that life is a specific form of dynamics which can be abstracted

[3] Kauffman 2008, 2002, 2000; Deacon 2012, 2006; Hameroff 2007, 2003; Hameroff and Tuszynski 2004

away from any particular medium (1966). Interestingly enough, some postmodern biophilosophers, although their methods have nothing in common with the analysis methods of the natural sciences, support the strong AL project insofar as they often include real and possible future products of the AL project in the phenomenon of "life".

The differences between the varying forms of biophilosophy become clearer in the context of the question about the *nature* or *essence* of life. Here, too, biophilosophers influenced by Deleuze and other postmodern thinkers hold a distinctive position. They reject the idea that life has an "essence", underscoring instead the incomprehensibility of the phenomenon, namely its tendency to transcend any characteristics (Thacker 2005). Other biophilosophers, who do not follow postmodernism, consider the question of the *nature* or *essence* of life to be pivotal. Their answers reveal the basic metaphysical ideas with which they operate, which may vary considerably between different thinkers.

Today's philosophy of biology is built upon metaphysical assumptions about matter, causality, and mental agency (and their respective places in the cosmos) that are substantially different from the metaphysical assumptions of Aristotelian, Jonasian, Whiteheadian and other biophilosophy. Most philosophers of biology follow the metaphysical principles of classical physics, of course in a version that is expanded to include the idea of dynamical systems, which include the theories of complexity, self-organization, and chaos. For the purposes of this volume, the following basic metaphysical principles are important, since they are explicitly rejected by biophilosophers who have a process-metaphysical or other perspective:

- Mental activity is inseparably connected to brain activity. Plants, simple multi-cell organisms and single-cell organisms do not experience anything. The ability to experience arose relatively late in the history of evolution and is reducible to complex physicochemical patterns of activity in neural systems.
- Mental or other factors which cannot be reduced to physicochemical processes possess no causal relevance for biological occurrences. Mental

states are irrelevant to ontogenesis[4] and evolution, even though they may appear to be an important evolutionary factor due to their role in partner selection.[5] In reality, however, they are causally irrelevant epiphenomena which can be reduced to the interaction of neural, genetic, and signal networks.

- All processes in an organism can be understood as arising from the interactions of material entities that are strictly localized spatio-temporally. Ideas in quantum physics such as the non-local entanglement between elementary particles are generally not considered to be relevant in biology (including brain physiology). For this reason the ideas of classical physics about matter and determinism – again, in a version expanded by the theories of complexity, self-organization, and chaos – are sufficient for understanding the causal relations in biological processes (e.g., signal processes as well as metabolic, genetic and neural networks).

The focus on the classical-physical notion of matter and causality means that the last basic assumption directly supports the first. This is the case because – in stark contrast to quantum theory – classical physics (and with it also theories of complexity, self-organization, and chaos) excludes any form of subjectivity from physical causality.

It should be noted that these assumptions do not say anything about the *methodology* of biology, as they are ontological and metaphysical assumptions about the nature of the matter and causality of organisms. Philosophers of biology are often skeptical when methods from physics are carried over and applied to biology.[6] As metaphysical assumptions,

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[4] Aristotle, on the other hand, argues that mental factors have an effect on and form matter, and makes them the foundation of his teleology (Koutroufinis, this book, section 2.3).

[5] Darwin's concept of "sexual selection", which is central in his work *The Descent of Man, and Selection in Relation to Sex*, was founded on the idea that experience and appreciation of beauty are fundamental in the mate selection of even simple animals like insects (1989, 304). Contemporary treatises on sexual selection avoid using any terms which could be associated with mental activity and especially with experience (Zahavi 1975, 1997).

[6] For example, one of the problems often discussed in philosophy of biology is whether there are causal factors at work in evolution that can be thought of as being similar to physical forces.

however, they indicate the *Weltanschauung* of modern biology. The vast majority of biologists are convinced that life can be explained "naturalistically". In this case "naturalism" is hardly ever defined, even if the author explicitly describes him or herself as a "naturalist". The naturalism of most biologists is usually a particular form of physicalism which does not even consider notions of matter and causality that have long been established within quantum physics. This means that, in most cases, the metaphysics of the physicalistic naturalism of contemporary biology is the metaphysics of physics *before* the development of quantum theory. The most central characteristic of this naturalism is that there must be no relying on the so-called "supernatural" in scientific explanations. This usually includes not only ideas of God but also everything which cannot be understood using the methods of physics (and chemistry); in other words, this also includes interiority or phenomenal qualities (qualia) of experience and other mental phenomena. From this point of view, since nature is considered to be purely the totality of material and energetic phenomena, mental agency can only be considered as "supernatural".

Whereas most philosophers of biology operate within this metaphysical framework dictated by contemporary mainstream biology, the basic assumptions of some biophilosophers break these barriers. However, this does not mean that they reject naturalism. These biophilosophers can be seen as representatives of an expanded form of naturalism – a *liberal naturalism*. Over the past few years several philosophers have introduced this new form of naturalism.[7] It allows mental states, such as phenomenal qualities, as aspects of natural entities and ascribes ontological relevance to abstract, modal, moral, and intentional entities.[8] John Dupré, a philosopher of biology and decisive critic of scientific monism (2004), is one of the supporters of liberal naturalism (2010). Dupré's work shows that there can be a continuous transition between philosophy of biology and the broader field of biophilosophy. His main epistemological and ontological positions could be advocated by biophilosophers who follow Whitehead's philosophy of life. In the past the borders of philosophy of biology within biophilosophy have often shifted. This will probably happen again in the

[7] De Caro and Macarthur 2010a; De Caro and Voltolini 2010, 75-82; McDowell 2004
[8] De Caro and Macarthur 2010b, 12

future. Those borders depend on the main ontological assumptions of philosophers of biology which are influenced by the prevalent metaphysical paradigm of main stream biology that might change.

Just why most contemporary philosophers of biology seem unwilling to follow such a liberal naturalism can be explained by recognizing the inordinate historical influence of one branch of biology, namely theoretical biology. This discipline began in the early 20th century with the works of Johannes Reinke (1901), Jakob von Uexküll (1909, 1920), and Julius Schaxel (1919) aimed to develop a philosophically consistent foundation for biology. But in the 1920s, Alfred Lotka (1925) and Vito Volterra (1926, 1931) developed mathematical models of population dynamics and became the forerunners of the systematic mathematization of theoretical biology, which began in earnest in the 1930s with the works of Ludwig von Bertalanffy (1932). Important contributions to the founding of mathematical theoretical biology were also made by Nicolas Rashevsky (1938, 1940), Erwin Schrödinger (1944) and Alan Turing (1952). With the development of theories of nonlinear dynamic systems and the derivative concepts of self-organization, chaos and complexity following the pioneering contributions of William R. Ashby (1962)[9], Heinz von Foerster (1960, 1962), Ilya Prigogine (1967, 1968)[10], Hermann Haken (1973, 1983) theoretical biology became a mathematical discipline[11] – which is why it is often referred to as "biomathematics". As a result, the originally wide range of topics became much more limited. In today's institutes of theoretical biology, it is mainly mathematical models and computer simulations for processes from evolution theory, developmental biology, ecology, neurobiology and epidemiology that are tested. In other words, it seems that only the branch of theoretical biology which can be traced back to Bertalanffy has survived. But even here, several of Bertalanffy's important philosophical intuitions have disappeared from view.[12] In this

[9] The term "self-organizing system" was introduced into scientific discourse by Ashby 1947.

[10] Prigogine and Nicolis 1967, Prigogine and Lefever 1968. See also: Glansdorff and Prigogine 1971, Nicolis and Prigogine 1977, Prigogine and Stengers 1984

[11] Kauffman 1995, 1993; Murray 1993; Goodwin 1994; Goldbeter 1997; Noble 2006

[12] In his book *Problems of Life* (first published in German 1949), Bertalanffy speaks of a new "non-quantitative" mathematics (also "Gestalt mathematics") for biology, in

way the change of theoretical biology to biomathematics has led to a large gap in regards to theoretic reflections about the foundations of biology as a scientific discipline. Today, this gap is increasingly being closed by philosophy of biology, which addresses such topics as the relation of biology to physics and chemistry; the concepts of natural selection and adaptation; the level or levels at which natural selection acts (genes, organisms or groups of organisms); the concept of the gene; the meaning of teleology, purpose, and function; the relationship between micro- and macroevolution; the nature of biological species; the emergence of humankind in evolution; the role of genetic factors in human behavior; the relation of biology to ethics; ecology and the concept of ecological diversity; and the conflict between evolution and theism.[13] The wide range of these topics shows that the borders between theoretical biology and philosophy of biology are fluid; this also explains the very close connection between the latter and the metaphysics of mainstream biology.

Due to its long development since classical antiquity, biophilosophy is able to exhibit different naturalistic understandings of life in general and of the organism in particular which transcend the physicalistic metaphysics of most biologists. For each of these directions several aspects are essential. Aristotle was convinced of the fact that factors of a non-material nature regulate the growth and self-preservation of an organism.[14] Contemporary biophilosophers have further developed this idea. Hans Jonas, who is strongly influenced by Aristotle's view of teleology, stresses the interiority and freedom of every organism (2001). Adolf Portmann describes the "Tiergestalt" (animal-gestalt) as an expression of interiority, which he understands as the richness of experience of an animal organism (1960). Prior to this, in his work *The Descent of Man*, Charles Darwin had established the notion of sexual selection, and stated that, in this form of selection, *acts of experience* occupy a central role, even for non-complex animals.

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which not quantity but rather the idea of form or order would come to occupy the central role (1952, 159-160).

[13] Rosenberg and McShea 2008, Hull and Ruse 2007, Griffiths 1992, Rosenberg 1985

[14] *On the Soul* II and *Physics* II

2. The need for a process-metaphysical biophilosophy

The self-limitation of contemporary biosciences and philosophy of biology to the physicalistic metaphysical principles about causality, matter, and mental agency mentioned above causes serious difficulties in understanding essential aspects of life.

Firstly, the reduction of organismic processes (e.g. signal, metabolic, and genetic processes) to the interaction of spatio-temporally strictly localized material entities (atoms and molecules) the nature or essence of which is fixed (substantialism) makes it impossible to understand the self-organization of real organisms. Theorists of self-organization, dynamical systems, and complexity as well as systems-biologists (who apply these theories to biology) face fundamental limitations in explaining the dynamics of a whole organism, e.g. a cell, as mutual interrelatedness of a big number of organismic processes without making unrealistic pre-assumptions.[15] The theory of self-organization can sufficiently describe non-living dynamical systems of physics. But in order to provide persuasive models of organismic self-organization it needs first of all to develop a well defined conception of *self*.[16] Organismic self has to be conceived of as a form of dynamics which transcends physicalistic metaphysics insofar as it autonomously makes an important distinction which constitutes the organism – it determines its own boundaries which necessarily defines its own physical surroundings or non-self. Physicalistic metaphysics does not provide a sufficient basis for explaining how a complex entity manages to differentiate itself from its physical surroundings. Physical systems require that an external factor defines their limits, thus making the distinction between what belongs to the system and what to its surroundings. In contrast all organisms, even the simplest bacterium, make this essential distinction on their own. Organismic self-maintenance and self-creation requires that the living self is able to sustain the flux of energy and matter from its physical surroundings by its own dynamics. This means that a living being must be able to interpret what

[15] Koutroufinis in this book (section 1.3, 1.4); 2013, 323-327; Deacon and Koutroufinis (forthcoming); Koutroufinis and Wessel 2013

[16] Deacon and Koutroufinis (forthcoming), Koutroufinis 1996

part of its physical surroundings is relevant to it. It separates the part of its non-self that is relevant to its own life from the irrelevant part. Those features of the physical surroundings that are represented with respect to the maintenance of internal organismic dynamics constitute what Jakob von Uexküll termed *Umwelt*. Self and *Umwelt* are two sides of the same coin. This indissoluble connection is not comprehensible from the point of view of a physicalistic metaphysics, since non-living physical systems have neither *Umwelt* (they have only externally set surroundings) nor self.

Secondly, the autonomous constitution of self and *Umwelt* are indissolubly connected to the end-directedness or teleology of organismic dynamics. Given the ignorance of classical physics for *Umwelt* and self it is not surprising that one of its most important principles since its foundation in the 17th century is that teleology has to be totally excluded from the study of nature. However, in the last century a new kind of teleological thinking was reintroduced by cybernetics,[17] evolution theory,[18] and theory of self-organization[19].[20] Teleology is purposeful end-directedness. As such it requires both memory and anticipation of future events to some degree. Without these faculties organismic dynamics would not be able to adjust non-simultaneous processes in such a way that early processes provide supportive conditions for the occurrence of later ones as happens in all healthy organisms.

Thirdly, physicalistic metaphysics and Neo-Darwinism cannot explain the growth of interiority and the progressive complexification of experience in evolution. Animal experiences are usually teleologically organized since they are directed to a certain end-state. For example the olfactory experience of an animal which finds its nourishment by following a gradient of odor intensity to its source is not an end in itself but serves for the sustainment of the living self. In other words, organismic teleology is not only a purposeful end-directedness but also an intentional one. But within the framework of physicalistic reductionism phenomenal qualities

[17] Rosenbleuth, Wiener , and Bigellow 1943

[18] Deacon 2012, 421-462; Ariew 2007; Bedau 1998; Mayr 1991, 56; Brandon 1990, 188; Ruse 1988, 44; Hull 1974, 103

[19] Christensen 1996

[20] For more details about the reintroduction of teleological thought in natural sciences see Koutroufinis 2013.

(qualia) – such as the experience of joy, hunger, beauty, fear, sympathy, and antipathy – are understood as epiphenomena of complex blind (not mental) physicochemical processes. Epiphenomenalism and materialistic eliminativism force biologists to reject the causal relevance of the interiority of experience to the behavior even of higher animals. When viewed from this perspective, using mental factors to explain the striving of organisms for nourishment, safety, procreation, or getting to a particular place makes no sense. However, from an evolutionary point of view the rejection of the causal relevance of qualitative phenomena raises an unanswerable question: if qualia have no function in physical reality why has the ability of qualitative experience been positively selected by evolution instead of having disappeared long ago? Obviously it is impossible to think seriously about the interiority of experience without having a sufficient theory of self, i.e., one which includes the ability of phenomenological experience.

Fourthly, following the main metaphysical assumptions of classical physics reduces matter to spatio-temporally strictly localized particles and causality to determinism (which includes deterministic chaos). This precludes essential quantum-theoretical ideas, like non-local entanglement and indeterminism, from theory of life. Recently, however, a number of publications in leading scientific journals demonstrate that in their long evolution organisms have found ways to utilize quantum phenomena.[21] Today there is a lot of evidence that quantum coherence plays an important role in metabolic and neuronal processes.[22] Quantum biology is a rapidly emerging discipline. Its foundation, however, can be traced back to pioneers of quantum theory, like Niels Bohr, Werner Heisenberg, Walter Heitler, Walter Elsasser, and Pascual Jordan.[23] Quantum biology is of great philosophical relevance. As it is based on quantum theory, which has introduced a new view of the subject-object relation, quantum biology supports the establishment of a new understanding of the role of

[21] Collini et al. 2010, Engel et al. 2007, Lee et al. 2007

[22] Davia, 2006, 268ff; King 2006, 439; 1996, 208ff; Mershin et al. 2006, 103ff; Hameroff and Tuszynski 2004, 28ff.

[23] Bohr 1933[1990]; Heisenberg 1984[1990]; Heitler 1976[1990]; Elsasser 1990, 1982; Jordan 1947, 1972[1990]

subjectivity and freedom in the theory of organism, neurobiology, and evolution theory.

Whiteheadian metaphysics allows one to avoid all four shortcomings of physicalistic biology and philosophy of biology. We shall see in the following section that it is ideally suited to creating a biophilosophy that integrates the essential aspects of self, *Umwelt*, experience, and macroscopic quantum coherence of organismic processes as these are also essential aspects of Whiteheadian ontology.

3. The foundation of Whitehead's metaphysics

The mathematician, physicist and philosopher Alfred North Whitehead (1861-1947) succeeded in becoming the best known representative of *process philosophy*, a discipline which arose around 1900 and is now accepted as an independent philosophical tradition. Genuine process philosophical ideas can be found in the writings of Friedrich Nietzsche, Charles Sanders Peirce, Henri Bergson, William James, Samuel Alexander, John Dewey, Nicholas Rescher, and of course in the works of the Whitehead-scholar Charles Hartshorne. In his process philosophy, Whitehead introduces a new kind of teleological thinking which is not based on any type of substance ontology. Process philosophy provides interesting ways to avoid the problems of vitalism and allows the principal problems inherent in an understanding of life based on contemporary natural sciences to be overcome.

The purpose of the following summary of the basics of Whitehead's ontology is to introduce readers to the common themes which run through the contributions in this book. For Whitehead's philosophy in general we refer you to the extensive secondary literature.[24]

[24] Leclerc 1975; Sherburne 1961; Lowe 1966, 1985, 1990; Christian 1967; Emmet 1981; Lango 1972; Kraus 1979; Fetz 1981; Hampe 1998; Rust 1987; Sayer 1999

3.1 Actual entities: the final facts are processes

The basic premise of all process philosophies is that all primary entities in the universe are processes. Everything which persists in space time is understood as the result of sequential manifestations of interconnected and interrelated processes. Whitehead calls the most elementary, indivisible facts of reality *actual entities* or *actual occasions*. In Whitehead's metaphysics, this ontological category takes over the role of the "primary substance" in Aristotle's philosophy. However, in virtue of being processes, actual occasions cannot be appropriately understood if any of the possible meanings of "substance" in philosophical, scientific, and every day language are applied to them.

> "'Actual entities' – also termed 'actual occasions' – are the final real things of which the world is made up. There is no going behind actual entities to find anything more real. They differ among themselves: God is an actual entity, and so is the most trivial puff of existence in far-off empty space. [...] The final facts are, all alike, actual entities [...] The notion of 'substance' is transformed into that of 'actual entity'" (1979, 18f.).

In his main work, *Process and Reality*, Whitehead often characterizes actual entities as "*res vera* in the Cartesian sense of that term" (1979, XIII) which means things that they are "real and true" (ibid., 74). But other than Descartes, who "retained in his metaphysical doctrine the Aristotelian dominance of the category of 'quality' over that of 'relatedness'", Whitehead anchors his central argument on the basic assumption that "'relatedness' is dominant over 'quality'" (ibid.).[25]

3.1.a. Physical-mental bipolarity

A second basic premise of Whitehead's metaphysics is the assumption that actual entities or actual occasion are inseparable *physical-mental unities* – one of the key ways in which he shows an affinity to Leibniz. It is in this way that Whitehead reacts to what he calls the "bifurcation of nature", the

[25] See section 3.1.b of this introduction.

separation of nature into mind and matter that has played dominant role in philosophy and science since the 17th century. According to Whitehead, this is the only way to integrate even the most simple act of experience into a nature devoid of "mind". That increasing the neuronal complexity of a dynamics based solely on efficient causation should lead to the sudden addition of an inner dimension of experience is something that Whitehead considers – justifiably – incomprehensible. Therefore, he conceives of the actual entities as *processes of experience*, which he calls subjects of their own experienced immediacy:

> "The actualities of the Universe are processes of experience, each process an individual fact" (1967, 197).
> "An actual entity is called the 'subject' of its own immediacy" (1979, 25).

Actual entities are physical-mental bipolar unities. They are entities endowed with subjectivity that are always related to and can also generate things existing physically in space-time (see 3.2.b). While Whitehead's process philosophy is based on a *pansubjective* ontology it cannot necessarily be categorized as panpsyschism.[26]

For his part, Whitehead does not tire of arguing against equating mental activity with consciousness. Like Aristotle and Leibniz, Whitehead explains that the term "mental" is much more comprehensive than "conscious", as only very few mental phenomena can be classified as possessing consciousness. Nearly all actual entities are merely *protomental* events and as such they are not "conscious".[27] Different processes are configurations of widely variable type and may exhibit any number of grades of consciousness, including a complete lack thereof, depending on their complexity. *But all processes are complexes of experience*. Thus, the idea of experience plays a much greater role in Whitehead's concept of a subject than does the idea of consciousness.

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[26] According to Wiehl Whiteheadian pansubjectivism is a revised panpsychism (1990, 217).

[27] Aristotle makes this clear in *Physics* II, 199 b26-30, Leibniz in *Monadology*, §19 and in *Principles of Nature and Grace*, §4, and Whitehead in *Process and Reality* (25, 53, 56, 139, 280), *The Function of Reason* (16, 32, 33), and *Adventures of Ideas* (180).

Whitehead's metaphysics can also be assigned to liberal naturalism. Only those philosophers who subscribe to the narrow concept of physicalistic naturalism, described above, are surprised to hear that Whitehead's philosophy of nature is a special kind of naturalism.[28]

3.1.b. Internal relationality

One of the main reasons for Whitehead to depart from the old metaphysics of substance was that, in his opinion, "[t]he relations between individual substances constitute metaphysical nuisances: there is no place for them" (1979, 137). The Cartesian substance as something that "exists in such a way that it doesn't depend on anything else for its existence"[29] is conceived of as being self-sufficient. As such it requires no relation to anything else in order to exist. Whitehead explicitly distances himself from this conception of substance (ibid. 59). He also thinks that the concept of the actual entity is inconsistent with Aristotle's "primary substance" in his early work, which is "neither predicable of a subject nor present in a subject".[30] However, Whitehead clearly sees the conceptual difference of Cartesian substance from Aristotelian "primary substance" (ibid. 137-138).

The actual entities are subjects, but not in the sense of the classical metaphysical idea of subjectivity as a feature of a substance. As a processual subject is not a substance, it cannot relate to its own experiences as a timeless carrier, the essence of which is not changed by its experiences. Therefore, Whitehead's way is only possible if one does not separate the *essence* of the processual subject from its experiences. He conceives of the actual entity (that is, the processual subject) as a totality of experiences that grows together to form a whole. The source of these experiences cannot be found only within the subject, as this is after all not the window-less monadic substance as described by Leibniz in his *Monadology*. The processual subject must be able to experience things through the "window" of its relation to reality that consists of the totality

[28] Griffin shows in what respect Whitehead's philosophy of nature is a specific kind of naturalism (this book).
[29] Descartes, *Principles of Philosophy*, Part I, §51.
[30] Aristotle, *Categories*, Chapter 5.

of all processes. Thus, each actual entity is a process in which the experiences it has with other processual subjects merge together to form an integrated experience:

> "The final facts are, all alike, actual entities; and these actual entities are drops of experience, complex and interdependent" (ibid. 18).

Every process has experience-relations to other already existing processes that occupy concrete positions in space-time. It is these relations which make up the essence of the process. These kinds of relations, which are indispensable to the essence of the related entities, are usually called "internal relations". Whitehead calls them *prehensions*.

The third fundamental of Whitehead's ontology – the internal relationality *between* the actual entities – is an automatic consequence of the connection between processuality and subjectivity. If a process only comes about through experiencing relations with other processes, it cannot be disconnected even slightly from these relations, meaning that these relations are also necessarily internal.

It is arguably this inseparable connection between processuality and internal relationship that also creates the biggest difficulty in Whitehead's ontology: The process which gives rise to relations of experience exists prior to them neither logically nor temporally. The processual subject only comes into being through its relations with other subjects. This is something that can only be grasped intuitively, if at all, as it requires overcoming the boundaries of language, which demands that a subject exists before its predicates.

3.2. Process as growing together

It is against the background of these internal relations that the real distinctiveness of Whitehead's concept of process becomes apparent:

> "This internal relatedness is the reason why an event can be found only just *where* it is and *how* it is, – that is to say, in just one definite set of relationships. [...] This is what is meant by the very notion of internal relations" (1953, 155; italics by S.K.).

The essence of a primary entity, *what* it is, is inseparably connected to the place *where* it is (Whitehead 1979, 59f.) – "[t]hus an actual entity never moves: it is *where it is* and *what it is*" (ibid. 73; italics by S.K.). Both quotations also highlight that an actual entity (or actual occasion) cannot change ("how it is", "what it is"). In sharp contrast to the idea of substance, and especially its essential assumption of continuously persisting entities which can be integrated into various material structures,[31] Whitehead's processes "cannot have any external adventures", but "only the internal adventure of becoming. Its birth is its end" (ibid. 80). Thus, Whitehead's idea of process consists in a single act of becoming that elapses almost immediately after its completion. This understanding of process has little in common with the day-to-day notion of process, which also includes movement and change.

The core idea of Whitehead's metaphysics of process is that the self-creation of a process is the growing together of the many already completed (but not yet elapsed) prehended entities to form a new actual entity. After their completion, these actual occasions exist in space for only a short time and can be prehended. Whitehead calls the process, i.e., the new actual entity that arises from the integration of the prehensions *concrescence*, from the Latin verb "concresco" meaning "growing together". Therefore, the actual entities are acts of self-constitution, processes of forming a certain configuration. The essence of an actual entity includes *experiencing* its own self-creation to a new unity by means of the integration of its internal relations.

3.2.a. A different conception of causality – self and Umwelt

The growing together of the prehensions of a process to a unity of experience cannot be a deterministic procedure. For this to be the case, the process would have to be controlled by factors which influence it in a predetermined, i.e. in a non-processual, way, that is, by leading it to a predetermined end result. As non-processual factors they would have to be

[31] For example, Democritus and the mechanistic Atomists of the modern era considered atoms to be everlasting particles moving in a vacuum.

entities existing independently of the inner dynamics of the process which the process has incorporated through its prehensions. However, the nature of actual entities precludes the possibility of entities whose essence is unchangeably determined from controlling their development. This is because Whitehead does not conceive of "concrescence" as the recombination of prehended contents to a new conglomerate as if they were atomic modules. "Growing together" means that the integrated contents are broken down into their elements, which are then synthesized into a new whole. The process is controlled neither by deterministic efficient causation nor by unchangeable teleological final causation. The processual essence of actual entities consists in a self-creation for which the rules and facts of ideal and physical reality (i.e., maths, logic, mental content, the laws of nature, physical facts etc.) only provide the general framework of possibilities without determining the form of its self-creation. Therefore, every process contains a non-reducible *spontaneity* which results in its autonomous determination of its essence being unpredictable for ontological and not just epistemological reasons.

The idea of concrescence reveals an understanding of causality unique in the history of philosophy. The singularity of Whitehead's conception of causality consists in the fact that only things allowed into a process through its prehensions – meaning, ultimately, by the process itself – have causal relevance to this process. In other words: nothing external to an actual entity determines it – not even God, who Whitehead conceives of as being the most comprehensive process that coordinates all other processes. The factor which determines what can become an efficient cause for a given process is the subjectivity of the process itself. The process is a "teleological self-creation" (Whitehead 1967, 195), an act that creates its own teleology. It is teleological, not in the sense of substance of old metaphysics (which strives towards the aim determined by its fixed essence), but rather in the sense of a *processual teleology*: The process strives to determine its own essence. Finding its aim means determining the physical form which the completed process will have as a spatio-temporal fact. This striving towards finding its own aim is experienced by the process. The experience develops out of the evaluation of the relevance of prehended content for the process itself. Therefore, it is the teleology (or final causality) of the processual subject which decides what part of its

physical surroundings can become an efficient cause, what can be integrated as a causal factor into the process and how this integration will occur.

Each process of concrescence necessarily implies a distinction between the facts of its physical surroundings which are allowed to be integrated in the process and those which have been negatively selected. Thus each process of conscrescence, even the most primitive one, exhibits an essential similarity to living beings: it is a self and at the same time, necessarily, defines its *Umwelt*.

The logic of this conception of causality is practically diametrically opposed to the logic of classical physics, in which efficient causes determine the course of an event.[32] This means that the prehended facts of the past do not "push" the process into the future in the way in which the causality of classical physics does (including the theories of relativity, thermodynamics and dynamic systems theory). With Whitehead's idea of process, the present of a process has a special meaning: The more complex a process is, the less of what is happening in the present is a simple continuation of the past. The present is not the passive and trivial transition from a completed past into a predetermined future. This is because the process decides, in its present, which factors from the past are to be considered relevant and which role the selected factors will have in forming the future. It is also because of this creative decision-making process that an actual occasion persists for a certain amount of time, as a creative act cannot be infinitely short like the infinitesimal time interval dt in physics. To put it simply, creativity takes time.[33]

3.2.b. Meta-physical "movement": a jump into space-time

The many completed processes that a developing process encounters and prehends open up various possibilities of combining the prehended multiplicity into a new whole for the new concrescence. The process of

[32] Even in chaos theory the possible courses of development of a non-linear dynamics are determined.

[33] This is also the core idea of the process philosophy of Henri Bergson.

concrescence comes to its completion when all indeterminacies in relation to the realization of possibilities are eliminated. It is then that the new actual entity appears as a spatio-temporal fact. This concluding manifestation as spatio-temporally localized energy quantum is the expression of the act of a *decision* that consists in the realization of a single possibility for growing together (concrescence) and thereby the rejection of the remainder. In this way, the process internalizes a part of reality that is inseparably connected to it and gives it new meaning by creating and manifesting itself as a new part of reality. Whitehead's process is an elementary vibration, a "polar occurrence of internalization and externalization" (Wiehl 1990, 228f.), whose birth as a spatio-temporal datum is only possible at the conclusion of its becoming, i.e., on determination of its own essence. It contains an "inner ambition which seeks to realize a particular energy quantum in a particular spatio-temporal region of the extensive continuum" (ibid.). In this way, Whitehead's process is not a physical, but rather a meta-physical "movement": "a movement before the movement of movable things" (Wiehl 1991, 326). It is a "jump" from a non-physical realm of being into physical reality (Whitehead 1953, 45). It is with this jump that, at the end of its becoming, the actual occasion achieves spatio-temporal existence and can be prehended by other processes.

Many modern interpretations of Whitehead's process philosophy agree that the concept of the actual entity is an inspiring description of *quantum-physical* actualization processes.[34] This involves the collapse of wave functions to spatio-temporally localised particles – in other words, to microphysical entities which only manifest themselves spatio-temporally for an infinitesimally short period of time at the end of this collapse.

3.3. Processes form societies

A characteristic common to all actual entities – with the exception of God – is that they do not persist for long periods of time. As processes their

[34] Chew 2004, 88; Stapp (this volume), 2004, 100; Malin 2004, 80; Jungerman 2000, 83; Lowe 1990, 232; Sherburne 1961, 78f.; Fetz 1981, 252.

justification for existence is lost as soon as they have completed their becoming or, in other words, when they have a defined essence like the substances of classical metaphysics.

Only entities that consist of groups of actual occasions are able to have a longer lifespan. Whitehead uses the term *nexus* to collectively describe all possible forms of accumulation of interconnected processes. Nexūs[35] are groups whose members form a connection – which can be either loose or compact – by means of prehensions. Whitehead considers objects of our sensory and scientific experience whose parts are connected in a complex and coherent way (e.g., cliffs, organisms, ecosystems, molecules, atoms, elementary particles, computers, buildings, planets, galaxies, vortexes, flames, and so on) to be a special form of nexūs which he calls *societies*. All societies have a common element of form which persists in time.

It is this element of form, which Whitehead also calls "defining characteristic" (1979, 34), which defines the form of a society. It allows a society to move coherently and to constantly develop. This element preserves the identity of the society and is inherited by the members of the society (the actual occasions) from their predecessors. Nearly all societies consist of parallel "strands" of inheritance and passing-down by means of prehensions (ibid. 35). In this case "strand" means a sequence of actual occasions in which each process is connected (via prehensions) more closely to one particular other process in its immediate past that to any other process. However, these strands are interwoven like the strands of a fabric, because the members prehend not only their immediate predecessor (which they replace) but also the members of neighboring strands, albeit much less intensively.

In this way, the individual processes that make up a society are knots in a network of mutual interdependence of essence. This network of internal relations gives the societies the stability necessary for a continuous development in space-time. Because of their internal relations, societies are markedly different from the network of efficient causation described by the dynamic systems theory of physics. The elements of such networks are thought of as entities that have a fixed essence (e.g., molecules or genes) that allow only external relations between them.

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[35] Whitehead uses "nexūs" as the plural of "nexus".

3.4. Abstract entities

The "defining characteristics" are forms that can be abstracted from the physical configuration of societies. These allow us to compare different societies to one another and to classify them. Abstract forms are complex conceptual entities that can be analyzed in simpler forms, such as numbers, geometric figures or types of elementary physical entities (e.g., electrons or photons). It is this that makes the scientific examination of nature possible.

According to Whitehead, abstract forms are not only of great importance but also have their own existence. He considers them to be timeless abstract entities which he calls *eternal objects*. They are "pure potentials for the specific determination of fact, *or* forms of definiteness" (ibid. 22). In process philosophy they assume the function exercised by ideas in Plato's metaphysics and the universals of scholasticism (ibid. 44; 1958, 32). However, they differ from these in ways that cannot be discussed here. Eternal objects can be seen as universal forms which, in contrast to the forms in Aristotelian metaphysics (eide), are not actively forming factors.

In conceiving of eternal objects in this way, Whitehead's metaphysics exhibits a close connection to the philosophy of Plato. Whitehead himself considers his own philosophy to be a contemporary renewal of Plato's thought (1979, 39). Plato's influence on the metaphysics of process philosophy can be clearly seen in the adoption of such central Platonic terms as "participation". For example, the purpose of actual entities requires the participation in eternal objects:

> "The things which are temporal arise by their participation in the things which are eternal" (ibid. 40).

An actual entity that is in the process of self-configuration prehends not only other actual entities but also eternal objects. The latter bring ideal forms of being into the developing process. They show the emerging process the clearly defined possibilities available to it from which it must choose.

3.5. Living societies, living occasions, and the entirely living nexus – the origin of organismic self and Umwelt

Living creatures are a special kind of society. Central to Whitehead's understanding of life is that a society can only be regarded as being alive if it also includes actual occasions whose mental pole is of considerable originality (ibid. 103). Whitehead calls these processes *living occasions* (ibid. 104). The totality of living occasions of a living creature amounts to an "entirely living nexus". A society is only then alive if it is controlled by such a nexus (ibid. 103). The entirely living nexus is the core of a *living society* (Whitehead's term for living beings) without being a society itself (ibid.). This is the case because its members are far too creative to limit themselves to the inheritance and passing-on of a particular defining characteristic. Living occasions add something to the life of an organism that had not been realized previously in either the entirely living nexus or the remaining living society.

The entirely living nexus is markedly different from Aristotle's concept of the soul. It is thought of in terms of process-metaphysics and, moreover, is not ontologically different from the rest of the living society – it is composed of actual occasions in the same way that the rest of the living creature is. In contrast to Aristotle's biophilosophy, which differentiates between an active and passive principle (i.e., between the soul and the body), there is no *ontological dualism* between living occasions and the rest of the living society. Therefore, Whitehead is no "cryptovitalist" as claimed by Ernst Mayr (2000, 353), since he does not assume that, living beings are equipped with a specific vital force alien to non-living matter, which Mayr considers to be the essence of vitalism (ibid. 418). Living occasions are nothing but actual entities. Their distinctiveness consists in their spontaneity, as their development does not conform entirely to the past which they inherit. For this reason, they cannot be explained only by the laws of nature. They bring something new to the history of a living creature that cannot be explained with the conceptions of causality of natural science, because it is not only the effect of the past of the living creature and its physical surroundings. Living occasions exhibit a stronger *selfhood* than ordinary processes of concrescence. As a result, in living

occasions the distinction between *Umwelt* and mere physical surroundings is stronger than in ordinary actual occasions.

The foundation of any biophilosophy inspired by Whitehead must be the idea that Jonas, too, identified as a basic principle of his biophilosophy – "that the organic even in its lowest forms prefigures mind" (2001, 1).[36] From the perspective of a Whiteheadian biophilosophy, biomathematics would only be able to explain living creatures if they had no living occasions, that is if they were only societies. Any kind of thinking that is based on efficient causation (it is this kind of thinking that forms the basis of biomathematical modeling) requires that certain regularities, be they universal (the laws of nature) or only valid for a particular organism (emergent laws), exert permanent influence on an organism throughout its whole life-cycle. Whiteheadians recognize this point but do not see this as the foundation of life. From the point of view of a Whiteheadian biophilosophy, only the material manifestation of the living (i.e., the final manifestation of its processuality in space-time) can be adequately represented by using mathematical formulas; the creative base of livingness is outside the realm of quantitative-metric analysis.

Whiteheadian biophilosophy attempts to understand life's essence on the basis of a new metaphysics that is not substance-ontological or physicalistic as in the metaphysics of contemporary biosciences and philosophy of biology. Besides, Whiteheadian biophilosophy differs also from postmodern biophilosophy, because it does not emphasize the incomprehensibility of life which assumes life to have no essence.[37]

4. This book

All authors of the present anthology explicitly or implicitly focus on one or more of the four essential aspects of life mentioned above, as they are

[36] In this instance Jonas was clearly influenced by Whitehead, who claimed that *mental* factors play a decisive causal role in *every* organism, even the most simple. However, unlike Jonas, Whitehead does not make a strict separation between living and non-living things, as he supposes (proto)mental factors to exist in all quantum-physical processes.

[37] See Koutroufinis in this book (sections 1.5, 2.2, 2.3)

necessarily essential aspects of a Whiteheadian biophilosophy as well. The chapters of the book can be subdivided into three main thematic units: theory of organism, quantum biology, and evolution theory.

Barbara Muraca addresses the question of organismic teleology within biosciences from the point of view of both Kant's critical philosophy and Whitehead's ontology. She criticizes the anti-teleological intellectual attitude of most contemporary bioscientists because the current discussions about theories of self-organization and complexity and their applications within biology and ecology give new significance to the idea of teleology. Starting her analysis by distinguishing amongst different concepts of teleology, Muraca emphasizes the role of "internal purposiveness" in today's biology. She shows that purposiveness corresponds to a complex form of reciprocal causation. On the basis of Kant's analysis of "natural purposes" in the Critique of Judgment as well as her own criticism of self-organization theory Muraca argues that reciprocal causation is not sufficient to describe organisms adequately. She claims that a genuine teleology of nature implies the idea of anticipation. Finally, Muraca shows that Whitehead's "philosophy of organism" provides the ontological framework for a theory of organismic anticipation by avoiding any recourse to supernatural forces.

Gernot and Renate Falkner focus on the adaptive response of a unicellular organism to alterations of nutrition supply and discuss possible analogies between the process of physiological adaptation and Whitehead's "actual occasion" of experience. They show that physiological adaptation is based on a sequence of adaptive experiential events. The authors postulate that in each adaptive event, initiated by an environmental (*Umwelt*) alteration that perturbs a previously attained adapted state, organisms experience a state of tension when energy converting subsystems are not optimally conformed to each other. Energy converting subsystems of the cell conform to each other, until a new adapted state emerges. This process of physiological adaptation is composed of individual adaptive events that have a bipolar nature: in an initial phase the changing external concentration, perceived with the cellular constituents resulting from former adaptations, is interpreted with respect to an appropriate reconstruction of the cell for future activities. The result of this anticipatory interpretation then leads in the final phase to a new cellular

constituent, whose manifestation is then interpreted in subsequent adaptive events. In this regard adaptive events share essential features of Whitehead's "acts of becoming", by which an organismic self constantly re-creates itself in an experience of environmental (*Umwelt*) changes.

Spyridon Koutroufinis aims to demonstrate the suitability of some of Whitehead's main ideas for a natural philosophy of organismic ontogenesis based on a process-metaphysical understanding of teleology. He criticizes the assumption from which most bioscientists have proceeded, that organisms arise and preserve themselves by means of efficient causation and that only blind forces such as those studied by physics and chemistry, are at work in organisms. In the first part of his paper Koutroufinis shows that thinking of embryogenesis only in terms of efficient causation, which operates on the basis of the theory of nonlinear dynamical systems, poses serious problems. However, from the perspective of dynamical systems theory, which at the present time dominates theoretical biology, it makes sense to assume that each organism, during its own ontogenesis, often faces different possibilities of further development. On the basis of this assumption, in the second part of the paper it is argued that the Whiteheadian conceptions of the "actual entity" and the "entirely living nexus" allow one to consider ontogenetical developments as results of protomental teleological decisions between different possibilities of further development, without falling back to a vitalistic position or violating physical laws.

Jonathan Delafield-Butt proceeds on the assumption that purposeful behaviors of organisms fundamentally require prospective control to anticipate the future present. He presents two separate streams of thought that are closely analogous. The first is the process-metaphysics of Whitehead's "actual occasion" and the second is a perceptuomotor control theory from ecological psychology based on the "general tau theory". Both of these approaches explain a process of sensing, integrating, and acting in the world, but where the latter explains this process as occurring through space-time in a living animal, the former considers the process as a fundamental ontological construct. The juxtaposition of the two helps to inform each theory and so broaden our understanding of the component elements of the ontological unit and the psychophysical construct of a perception-action cycle. There are fundamental similarities between

Whitehead's ontological unit and the unit of action described by general tau theory, since they are both teleological psychophysical units.

Joseph Earley focuses on Whitehead's conviction that indeterminacy is essential for both life and mind and on his assumption that "life is a characteristic of 'empty space'". Earley suggests that Whitehead's "'empty' space" should be considered as a metaphorical space of indeterminacy and claims that necessary indeterminacy is likely to emerge in networks of inner-organismic relationships which are considered by systems biology. By reference to bistable chemical dynamics Earley demonstrates how a complex dynamic system can give rise to indeterministic behavior. Finally, he sketches a Neo-Whiteheadian metaphysical approach called "Process Structural Realism" that can incorporate both the findings and the essential ideas of systems biology.

Pete Gunter focuses on the recent emergence of quantum decoherence theory with the notion of entanglement and its rejection of the human observer as a necessary component of measurement. These developments, along with the discovery of quantum effects occurring at the level of large molecules and large collections of atoms (mesoscopic quantum effects), and quantum nonlocality now make it possible to reconceive organismic dynamics in non corpuscular-kinetic terms. Gunter explores attempts to create quantum biologies of the organism by Johnjoe McFadden, Mae-Wan Ho, and Peter Gariev. He concludes that in several respects quantum biology is markedly congenial with Whitehead's philosophy of nature. However, some reworking of the Whiteheadian metaphysics seems to be required in order to make it applicable to the new quantum theory.

Henry Stapp tries to integrate the role of human experience in thinking about mind-brain relationships. Based on quantum physics he provides a theory about how our conscious thoughts can affect our physically described brains. This theory depends on the shift from the mechanical conception of nature to the psychophysical conception that emerged from the findings of the pioneers of quantum theory. According to Stapp this shift converted the role of our conscious thoughts from that of passive observers of a causally closed physically described universe to that of active participants in an essentially psychophysical understanding of nature. Stapp unfolds a theory about the mind-brain relationship starting

from the assumption that psychophysical quantum events which can be described as Whiteheadian actual occasions take place in the brain.

John Cobb criticizes the standard Neo-Darwinistic explanation of evolution as only dealing with the random mutation of genes, the organisms that result from these, and the environment as selective agent. This enables biologists to think that a "materialist" account, one that excludes such things as the purposive behavior of animals based on their experiences, is adequate. However, Cobb argues, there is evidence that the actual course of evolution is far more complex. Far from being passive recipients of the effects of genetic change and environmental selection, organisms actively participate in shaping the course of evolution. Their activities affect the selection of genes through the Baldwin effect and also the character of the environment that selects. Cobb claims that the activity of organisms should be considered as an independent variable in any explanation of evolution. He thinks that resistance to accepting this comes largely from the desire of biologists to exclude any reference to the subjective, experiential side of organisms from their explanations. If they insist on doing so, they should recognize that their explanations are incomplete. According to Cobb the alternative is to expand the understanding of science to include the testing of hypotheses about the subjective side of nature.

Andrew Packard tries to deflect Cobb's criticism of the simplified version of Neo-Darwinism by providing three main arguments. First, that most of those who "accept" Neo-Darwinistic evolution theory are not required to test it and that its place in current teaching reflects cultural expectations and realities. Second, that all Neo-Darwinian formulations of evolution that are about the fate of genes or populations have a future reference: uncoupled, therefore, from the work of most biologists concerned with living processes in the present – or the story of evolution in the past. Third, there is a long tradition of Darwinian biologists who include subjective aspects of the organisms they study and ascribe to behaviour and the activities of the phenotype an important role in directing the course of evolution. In the second half of the chapter Packard approaches Whiteheadian understanding of the role of subjectivity by drawing on his own experience of psycho-physics and of the forms taken by pattern-recognition in the life histories of aquatic organisms.

David Griffin shows that what is generally considered the Neo-Darwinian theory of evolution can be characterized in terms of 13 doctrines, some empirical and some metaphysical in nature. Much of the discussion of Neo-Darwinism by both advocates and detractors is confused because it is not clear which of the 13 doctrines the speaker has in mind. Griffin suggests that from a Whiteheadian point of view, 4 of these doctrines are true, the other 9 false. Most of the false doctrines are ones that imply an atheistic worldview. Griffin argues that the atheism of Neo-Darwinism has led it to be strongly opposed by those who advocate "creation science" or at least "Intelligent Design". But these views are also unsatisfactory from a Whiteheadian point of view, because they reject the doctrine of naturalism, which is one of Neo-Darwinism's true doctrines. Griffin refers to naturalism in the generic sense, which simply rules out supernatural interruptions of the world's normal cause-effect relations (not the sensationist-atheist-materialist version of naturalism). After showing why the advocates of Neo-Darwinism and Intelligent Design usually talk past each other and why neither can see the elements of truth in the other view, Griffin suggests a Whiteheadian theory of evolution that, being naturalistic but not atheistic, and nondualistic but not materialistic, unlike Neo-Darwinism, is acceptable from a religious-moral perspective and one that, unlike Intelligent Design, is acceptable from a scientific point of view.

Robert Valenza claims that Whiteheadian metaphysics in particular and dual aspect theories in general allow that reality coheres in knots that admit experience. Such entities may carry a subject-centered phenomenal aspect, and some of the more complex ones also manifest a perspective-free epistemological aspect. Both aspects supply part of the basis for a rational ontology, but it is the latter that affords the possibility of a worldview, and, in particular, a community-wide ontological deployment that can be fully shared. Valenza claims that subjects distinguish world objects on the basis of a generalized conception of symmetry that often goes by the name covariance. In this light Valenza explores the hypothesis, suggested by the history of the world and science, that nature moves systematically toward the development of a covariant epistemology, and that this is reflected in the evolution of life forms of increasing complexity. Valenza claims that explanations of this dynamic might include, among others, Whitehead's theory of the relationship of God to actual entities in general.

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