Nature Alive

Nature Alive:

Essays on the Emergence and Evolution of Living Agents

Edited by

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Cambridge Scholars
Publishing

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This book first published 2018

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN (10): 1-5275-0610-X
ISBN (13): 978-1-5275-0610-7

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PREFACE

NATURE ALIVE: THE EMERGENCE AND EVOLUTION OF LIVING AGENTS

LUKASZ LAMZA AND ADAM C. SCARFE

1. Introduction

The title of this volume pays homage to Alfred North Whitehead's (1861-1947) profound lecture and essay entitled, "Nature Alive."[1] One of his later works, it appeared originally in *Nature and Life* (1934) and was later published in *Modes of Thought* (1938). "Nature Alive" is Whitehead's most mature expression of his process-relational vision of the processive and dynamic characters of the natural world and of the organisms that live within, and which help to compose, it. This is contrasted against the backdrop of a previous lecture and essay, entitled "Nature Lifeless."[2] Side by side, the two essays are meant to highlight the stark divergence between, on the one hand, the materialistic and mechanistic neo-Darwinian orientation with respect to the natural world and life, wherein Cartesian substance ontology and Newtonian physics are applied reductively as the comprehensive lenses with which to study them, and on the other hand, the more holistic, organismic, and process-relational orientation that Whitehead has in mind.

Whereas the one emphasizes empiricism with a focus on the objective present,[3] doing so without admitting any metaphysical presuppositions, the other views the natural world across past, present, and future from atop a speculative watchtower where diverse modes of perception (e.g., "causal efficacy," "presentational immediacy," and "symbolic reference")[4] are in play. Although the first emphasizes precise experimentation and measurement, the second highlights the need to incorporate holistic generalization into the methods of science. While the former employs the "machine metaphor" as a lens for studying nature and life, viewing them as comprised by a network of linear causal switches, dials, and levers that are there and "at the ready" to be manipulated, the latter employs an organismic metaphysics as a lens for studying them. Whereas the one cannot find any real purposiveness or "aim in nature"[5]—only the appearance of it, as in *teleonomy*—the other holds that teleology is discoverable in the organism's internally purposive homeostatic operations and in their ongoing "processes of self-creation,"[6] as in *autopoiesis*. While the first considers the basic ontological building blocks to be static material substances of the Cartesian variety that are dependent on nothing but themselves for their existence, the second takes the real things of which the world is made up to be complexly interdependent processes and finite events with beginnings and ends, namely, "actual entities,"[7] "occasions of experience,"[8] and "societies of occasions."[9] Whereas the former sees the world through the prism of external relations and linear causality, the latter suggests the inclusion of "internal relations" (i.e., relations of "mutual immanence" / "immanent causation"),[10] reciprocal relations, "causal nexūs,"[11] and "interconnectedness,"[12] in the context of the above "events."

While the one treats mind merely as an "epiphenomenon" of "the successive hurrying of [vacuous, 'simply located' bits of] matter through empty space,"[13] the other holds that nature and life have rhythmic characters, and that bodily feeling, emotion, mentality, behavior, habit, learning, and experience extend out further into the universe than many would be prepared to accept. Whereas the former interprets organisms as objects upon which natural selection happens to act, the latter sees organisms also as finitely free subjects or agents of selection who can "create their environments,"[14] and participate by way of their activities and behaviors in the eliminations and preservations that belong to the notion of natural selection. Although the one holds that genes provide the program for the growth, differentiation, and development of organisms, but these are not affected by environment, behavior, lifestyle and experience, the other emphasizes that the hereditary material can be affected by such factors in ways that can be inherited, as in epigenetics.[15] While the first emphasizes that the only efficient cause of evolutionary change is natural selection acting on genes or genomes, the second is open to the exploration of novel research areas (e.g., the "New Frontiers" of biology), namely, whose findings seem, to some extent, to go against the grain of the Modern Synthesis, which saw to the merger of natural selection and genetics as the foundational pillars of modern biology. Some of these areas include: Systems Biology, Emergence Theory, Epigenetics, The Theory of Organic Selection (also known as "The Baldwin Effect"), Niche Construction, Biosemiotics, Evolutionary Neo-Kantianism, Homeostasis, Chronobiology, and Autopoiesis research. And finally, where the one ends up in disenchantment, the other preserves "wonder."[16]

The contributors to this "Whiteheadian-titled" volume are not suggesting that we should merely disregard the former and affirm the latter, for the life sciences have been powerfully served, for at least the last seventy-five years, by the mechanistic neo-Darwinian paradigm. Nor is our focus merely on a scholarly contemplation of Whitehead's "navel." While Whitehead's process-relational philosophy does offer to us starting points for our respective reflections, it does not necessarily entail our finishing lines. For instance, perhaps some of us may find that nature is *not alive* in the general sense that is advanced by the Ancient Greeks, by "Gaia Theory," and by Deep Ecology (via the notion of capital-'S' Self-Realization), but rather only in a more limited sense that includes living organisms. And admittedly, there are some quibbles among the contributors along the way, for example, as pertains to: (1) whether organisms ought to be characterized as teleological agents or teleonomic agents; and (2) whether or not the notion of "mechanism" that is employed in the life sciences is to be taken in an explanatory or epistemological sense, as indicating a regular or predictable relation between phenomena, or rather in a metaphysical sense, namely, as a privileged, yet assumed and questionable, part of the whole battery of *a priori* concepts of the understanding that science "brings to the table of its experience" of nature and life. Some commonalities among our various stances are that we are among those who are inspired by Whitehead's vision, by some of the creative alternatives that it helps to generate for understanding the emergence and evolution of living agents, by the problems it may help to resolve in the life sciences, and by the possibilities that it affords for laying bare the abstractions that are created by the overemphasis on mechanistic reductionism in mainstream biology and contemporary philosophy of biology.

Mainstream neo-Darwinian biology's methodological reductionism involves an emphasis on the study of living creatures through an analysis of their material parts, considering these to be externally related only. During the twentieth century, this philosophically "neutral" method has been spectacularly fueled by the extraordinary technological development of the capability to observe and analyze living things in ever-smaller scales, down to individual molecules—which led to very intriguing worldview consequences. While seemingly this would render the life sciences increasingly more precise, it also gives rise to increasing abstraction. One of the chief purposes of this book is to show how more contemporary researches (i.e., the "New Frontiers" of biology) demonstrate the need for the life sciences to surpass their beholdenness to the reductionist method, yet at the same time, to maintain key aspects of it. For this reason, in what follows below, we provide a brief review a few elements of its history and to provide a glimpse into the foundations of the "mechanistic turn" in biology.

2. A Very Brief History of Some of the Methods by which Modern Biology Analyzes Living Organisms

By the end of the nineteenth century all of the main organelles of the eukaryotic cell had been observed and named. This was a development that was made possible by the ever more precise optical microscopes and ingenious staining techniques. Mitochondria were first identified as common components of cells in the 1890s, and in 1897, they received their current name. Camillo Golgi (1843-1926) identified the membrane system surrounding the nucleus in the same year, and, in 1898, it was named the "Golgi apparatus" after him. In 1932, the first images from the prototypic electron microscope were obtained—the tool that eventually defined our more contemporary conceptualization of the natures of living cells. Nowadays, cutting tissues and organisms into ultrathin slices and imaging them with an electron microscope is the traditional starting point in anatomy, and especially in microbiology. New species of microscopic eukaryotes are now typically defined by their appearance in scanning (SEM) and transmission (EM) electron microscopic images.

Starting from the 1930s, X-ray crystallography became the method of choice for the determination of the structure of biomolecules. In the 1950s, the molecular structure of the genetic material was discovered, and beginning in the 1950s and 1960s, increasingly more detailed structures of proteins became available. Computers now play a massive role in the prediction of protein structures, DNA and RNA folding, etc…. The 1980s and 1990s saw the great revolution in our ability to sequence the genomes of living organisms, the first major discovery being the polymerase chain reaction (PCR) in 1983. Now, it is becoming more and more commonplace to sequence whole genomes, and the list of genetically sequenced organisms is now in the thousands.

The twenty-first century brought increasing capabilities in: (1) manipulating single cells (through microfluidics); (2) visualizing selected molecules, even down to the level of individual molecules (through novel techniques of staining, such as the green fluorescent protein that earned its discoverers the Nobel Prize in Chemistry in 2008); and (3) modeling biomolecules down to the level of an individual atom (through massive computational applications of quantum chemistry).

3. From Methods to Worldviews—A Telling Example

Let us take a step back and see how the availability of these methods influences the way that biologists typically conceptualize the natures of organisms. We will use an example that we are best familiar with, namely, eukaryotic microbiology, but it seems that the general pattern holds also for other disciplines. Let us see how modern day scholars of protists (or protozoans; kingdom *Protista*) approach organisms.

A recent paper by Aaron Heiss *et al*., entitled "The Ultrastructure of *Ancyromonas*, a Eukaryote without Supergroup Affinities,"[17] studies a recently discovered protozoan of uncertain evolutionary affinities, *Ancyromonas sigmoides*. The authors advertise their paper as the first detailed study of that organism, and right away they inform the reader of their method of analysis by stating, "we used serial sectioning and TEM to produce a three-dimensional model of the flagellar apparatus, as well as of much of the cytoskeleton in the rest of the cell."[18] And that is in fact exactly what they do, with images of the properly selected fixed slices of the cell, and their later morphological analysis, taking up the most of the paper. The cytoskeleton and the flagellar apparatus were selected because they have historically proven to be very reliable characters for the determination of evolutionary relationships between protozoans. Most of the paper details the cytoskeleton of the cell—the set of long, strong rootlets spanning the cell—and the basis of the flagellar apparatus. There is not even a single mention of the behavior of the organism: its movement and dynamics, its feeding style, reaction to stimuli, reproductive patterns, forms of collective behavior, etc….

Just to provide the reader with a sense for how the method works in practice, consider the following typical paragraph:

> the posterior flagellar pocket and channel thus have a characteristic appearance in transverse section (Fig. 5F, G). They are framed on either side by L3 and L1, with L2 and the posterior singlet lining the dorsal side, nearest the anterior flagellum. Between the posterior singlet and L2 lies a cylindrical endomembrane vesicle, whose axis runs parallel to all posterior flagellar roots (Fig. 5D–G).[19]

What this paragraph is saying will likely be incomprehensible to a non-specialist, but we can treat it simply as a demonstration. The article is basically a very detailed description of the anatomy, almost entirely focused on the ultrastructural level, mentioning every single rootlet and filament of the cytoskeleton.

Contrast the above article with a paper entitled, "The Neuromotor System of *Oxytricha*,"[20] written by Everett Lund in 1935, before the methods used by Heiss *et al.* became widely available. The author starts with a description of the place from which the protozoans (ciliates from the genus *Oxytricha*) were harvested—a stream in Lebanon. It is worth noting that the abovementioned paper used a standardized laboratory culture of *Ancyromonas* (so the origin of the organisms was simply referred to through their culture number, "strain B-70"). While the fixing and staining of the protozoans was performed, it was preceded by a direct observation of live specimens through the optical microscope: "by far the most interesting and perhaps the most instructive studies were made on living specimens,"[21] notes the author. The procedure was tedious, and required great care, so that a tiny droplet of water, containing just the study's specimens, is squeezed between two ultrathin sheets of glass. Lund writes, "if the correct amount of fluid was left, each specimen was held gently in one place, for *Oxytricha* has a dorsal 'hump' that held it securely, without greatly affecting its proportions, or mutilating any of its parts."[22]

One observation that was made is that each of the eighteen cilia at the bottom (i.e., the ventral surface) of the organism has a specific function, much like arms and legs of animals. For instance, Lund writes,

> the first three frontal cirri are especially active in creeping, although they are used also for swimming. Frontal cirri 4 to 8 probably aid in compensating the effect of the membranelles in swimming, and are less powerful creeping devices. The last frontal cirrus may be of some aid in directing food into the cytostome.[23]

And so on. The first part of the article gives a description of what is traditionally called the "functional anatomy" of the cell, the purpose and "methods of use" of the elements of the organism, and it provides information about its pattern of movement, behavior, feeding methods, etc….

One interesting side note here is that the ciliates studies by Lund were becoming restless, when immobilized under the microscope, and so sedatives had to be used. After discussing the issue with his colleagues from the Department of Pharmacology, Lund decided to use barbituranes, the same ones that are used in human pharmacology, and they were effective. The protozoans were sedated for approximately thirty minutes, which allowed Lund to observe them with more ease.

4. Is the Mechanistic Worldview Really a Worldview?

The unspoken underlying metaphor behind Lund's paper is simply the metaphor of an organism, which was so obvious that it was not even openly mentioned. In the first decades of the twentieth century it was commonplace to speak of the "psychology" or "intelligence" of even very simple organisms, such as earthworms, protozoans, or bacteria. It might seem natural, if not obvious to think in this way—after all, all living creatures *are* organisms, almost by definition.

The reductionist method, simply through the resultant choice of language and imagery, leads to a considerably different worldview. A classical example, again from microbiology, would be the description of bacterial chemotaxis, i.e., the propensity of certain bacteria to direct their movement "upstream" certain chemical gradients (e.g., signaling the presence of food), and "downstream" the gradients of harmful substances. At the organismic level, it may be simply described as behavioral preference.

After considerable research throughout the twentieth century, the molecular basis of chemotaxis in certain species, notably *Escherichia coli*, is now well known. Therefore, it has become possible to describe a cascade of events, all at the molecular level, leading to chemotaxis. Such a description would involve the recognition of a given chemical agent by a specific membrane protein, the diffusion of a signaling molecule, its detection by the docking protein complex of the bacterial flagellum and the resultant modulation of its beating pattern.[24]

The resulting description is devoid of any strictly biological content. It is a sequence of chemical and biophysical processes that could very well take place outside of a living organism. It is as impartial and dispassionate as a medical description of death: cardiovascular activity ceases, the sequence of certain irreversible electrical and chemical changes occurs in the nervous system, etc…. It is all true. But is it still death we are talking about? Is there no middle ground?

4. A Second Example

Frans de Waal is a Dutch primatologist and ethologist, a student of Nikolaas Tinbergen, and one of most notable zoologists of the twentieth century. He is the author of a recent book entitled, *Are We Smart Enough to Know How Smart Animals Are?* (2016).[25] Tinbergen and de Waal have always been vocal proponents of finding a third ground between anthropomorphism and, to use a term coined by the latter of two, "anthropodenial."[26] Anthropomorphism is the erroneous concept that all living creatures *are* just like humans, possessing plans and desires; intelligent, emotional, conscious, and spiritual. But there does not seem to be a shred of evidence that bacteria or leeches are capable of conscious planning or abstract reasoning. After all, why would they? Why should they possess qualities that have clearly evolved among primates? However, de Waal forcefully defends the concept of "cognitive styles."[27] According to him, each animal that has a reasonably complex nervous system has been forced to solve certain problems that are typical for its habitat and lifestyle. In doing that for generations, it has evolved very specific mental or cognitive capabilities. And those differ wildly.

Great cats are solitary predators, yet canines hunt in packs. Therefore, completely different cognitive capabilities have evolved within these two closely related groups of mammals. Corvids are masters in remembering locations and individuals, and have generally very good memories, but for purely anatomical reasons they are not well equipped to manipulate small objects and to focus their attention on them. Apes, on the other hand, because of their ability to grasp objects, together with their "binocular visions," are naturally inclined to study small objects that are handed to them. Finally, an even more spectacular example of a "cognitive style" is swarm intelligence: individual bees forming a colony, or individual amoebae forming a slime mold aggregate, have a very simple behavioral and "cognitive" repertoire, and attributing complex problem-solving capabilities to them is plainly wrong. As a swarm, however, they do seem to be able to react adaptively to challenges and exhibit a very peculiar form of "intelligence." This is however, something wildly different from human intelligence, and it usually takes years of patient observation (and, usually, experimentation) to catch a glimpse of non-human cognitive styles. In short, we should *not* expect other species merely to be *stupider versions of humans*.

Twentieth century behaviorists were quick to fall into "anthropodenial," deeming all forms of language that refer to the human world, as inappropriate in discussing animal behavior. For instance, saying that a certain chimp "plans" or "intends" to do something is still seen as controversial, even though numerous high quality observations and carefully designed experiments seem to demonstrate the capability of those primates to plan ahead. However, another example, which is one of de Waal's favorites, involves the notion that certain species of primates, when welcoming each other after a long time, or when reconciling, move their lips to the cheek of the other individual, pressing them against it for a moment, which is sometimes accompanied by a loud cluck. In other words, they kiss. De Waal, after carefully studying this phenomenon, decided that it seems to be *the same behavior* as the one exhibited by humans, and so, avoiding its name in fear of anthropomorphism would seem to be overkill. That said, certain species of fish peck other fish, eating parasites that live on their skins. This is *not* kissing. There is a different evolutionary history pertaining to the behavior, a different function, and there are different mechanics involved. Numerous zoologists with a behavioristic orientation stubbornly refuse to accept the difference between primate kissing and fish kissing, and in describing chimpanzee behavior, they tend to resort to wearisome descriptions in the unsettlingly neutral and impartial language of anatomy and of the movements of body parts. What de Waal calls for here is a *smart anthropomorphism*.

5. Smart Mechanicism?

Generalizing from de Waal's *smart anthropomorphism*, what seems to be needed in the life sciences is a *smart mechanicism*, namely, a worldview, a language, and a methodology that finds a reasonable middle ground between the two extremes. On the one hand, it is the hard-nosed twentieth century mechanistic reductionism that reduces all actions to muscle twitches, all thoughts to electrochemical phenomena, and all life to molecular processes. While this view may be *formally correct*, it certainly seems to leave the readers, and the authors too, of scientific literature, with no real biological understanding whatsoever. On the other hand, there is the nebulous, romantic anthropomorphism that attributes conscious intentions to bacteria and romantic love to earthworms, without a shred of solid scientific data to back it up. While it may be *philosophically pleasing*, it also leads to no real improvement of our understanding of life.

Interestingly, *both* of these endpoints seem to stem from the unwillingness, or inability, to actually sympathize with or, *feel with* the organism being discussed. Overtly mechanistic neo-Darwinian biology does not acknowledge the existence of the "organism as a whole" and it does not even stop to ask "what is it like to be bat?"[28] But conversely, the overly romantic biology treats everything as miniature versions of humans. This essentially means the same thing: specifically, an unwillingness to consider that abstract reasoning or the higher emotions are simply *our* thing, and that we have no better reason to attribute them to snails than to treat our own culinary preferences as a *certain version* of what snails do, as they scrape bacterial films from solid surfaces with their radula.

In this volume, the authors attempt to find concepts and language that does justice to both perspectives at the same time. What we are interested in is a solid scientific orientation for the study of the natural world and *life*, one which: (1) does not confuse the living with the mechanical; (2) open-mindedly engages with philosophy; (3) embraces a phase of holistic reflection as part of its methodological core; (4) recognizes that science itself takes place within an evolutionary and environmental context; and (5) is not merely given over to technological, biotechnological (and other powerful) interests. As mentioned earlier, the philosophical tradition that serves as a point of departure for all of the contributors in this volume is the philosophy of organism—a highly abstract metaphysical system, described in a consistent and detailed fashion by Whitehead. This system describes everything as composed of microscopic *entities*, called technically *actual* entities, but which may also be called organisms. They are influenced by the past and "sense" the world around them, but it is not necessarily perception merely through sensory channels, nor is this experience necessarily conscious experience. Whitehead's technical term is "*prehension*."[29] Living organisms have preferences and aversions, but their experience is not necessarily cognitive. Whitehead's technical term here is "*valuation*."[30] Living organisms are active and creative agents in the process of their own becoming, but this does not entail a strict or absolute "free will" as we know it, that is completely independent from the evolutionary context or from the environment. By describing living things as "actual entities" (e.g., rather than as "machines"), the philosophy of organism aims not only to avoid anthropomorphism, but also "biomorphism." It is our hope that this volume can serve as a demonstration that, through philosophical reflection, it possible to go beyond some of the problematic dichotomies and extremes mentioned above, and to arrive at a smarter conceptual foundation for the life sciences.

6. A Very Brief "Teaser Trailer" for the Chapters Ahead

While in-depth, yet brief, synopses of each chapter of this volume are presented in the abstracts preceding them, below, we provide a short "teaser trailer" as regards their contents. In Chapter One, "Is Environmental Philosophy Compatible with Mechanistic Neo-Darwinism?: Organismic Agency, Intrinsic Purposiveness, and the 'New Frontiers' of Biology," Adam C. Scarfe suggests that the disciplines of environmental philosophy and ethics, as exemplified by Paul Taylor's "Ethics of Respect for Nature," are, in general, logically inconsistent with mainstream neo-Darwinian biology. However, after presenting substantive criticisms of some of the problematic assumptions that the initiators and proponents of mechanistic neo-Darwinism, such as Descartes, Huxley, Mayr, Dawkins, and Dennett, hold in relation to nature and life, he shows that if one attends to the "New Frontiers" of biology, and here especially, the theory of organic selection, epigenetics, homeostasis, chronobiology, and autopoiesis research, then the former's basic concepts (e.g., teleological centers of life; intrinsic value, etc…) are rendered more defensible. At the same time, environmental philosophers and ethicists do not get off "scot free." They will have to do more to attend to the life sciences in general as well as to reflect on their own questionable presuppositions about nature. Furthermore, by drawing from sources such as Sartre, Whitehead, and Piaget, Scarfe provides insights into the emergence and evolution of living agents, or of "intrinsically purposive loci of valuative-selective activity" as he refers to them, and sheds light on the nature of "mental autopoiesis" as it relates to such selective agency.

In Chapter Two, "Cells, Organisms, Colonies, Communities—The Fuzziness of Individuality in Modern Biology," Lukasz Lamza demonstrates how Whitehead's process philosophical language can help the life-sciences to better conceptualize and understand the objects of their study, namely, living organisms. Living creatures are organized in complex, dynamic, and relational ways, for example, as collectivities, as superorganisms, as multiorganellular and multicellular wholes, and in socially interdependent structures. As such, there is tremendous "blurriness" which "obscures the vision" of mainstream neo-Darwinism's mechanistic lens in its study of life, since it assumes a substance ontology that is ill-equipped to thinking of them beyond the confines of biological individuality and external relations. Lamza focuses especially on explaining how Whiteheadian terms such as "actual entities / occasions," "societies," and "living persons" can assist researchers in the life sciences to deal with such complexities of relatedness.

In Chapter Three, "The Emergence of Animal Mind: Shrinking the Explanatory Gap," Lawrence Cahoone employs both reductive and emergentist analytical methods in theorizing about the arising and evolution of consciousness in the natural world, something that remains highly problematic for neo-Darwinian biology. Defining consciousness in terms of activity, intentionality, and intensity of attention, for Cahoone, conciousness is a source of adaptive plasticity and teleonomic agency for living organisms. For example, it enables the organism to represent its somatic state or its environment to itself, as well as to re-prioritize novel action patterns stemming from behavioral learning, as contrasted with mere deployment of "fixed action patterns" (FAPs) involving unconscious habit.

In Chapter Four, "Possibility, Spontaneity, and the General Order of Nature: Toward a General Theory of Emergence," Philip Rose employs Charles Sanders Peirce's concepts of "firstness," "secondness," and "thirdness" (as well as the processive transition from the one to the next), in order to help us to better conceptualize the meaning of the key notion of "emergence." The notion of "emergence" counters the "reductionistic" tendency in mechanistic explanation that is, in general, considered basic in the life sciences. Challenging the assumed priority of "mechanism" that is present in reductionistic neo-Darwinism, Rose takes possibility and spontaneity as the ontological grounds constituting "firstness" within the evolutionary order of the universe, whereas the lawfulness, regularity, or uniformity that belongs to mechanism represents Peircean "secondness." The "generalizing tendency" that pertains to complex organisms is constitutes "thirdness."

In Chapter Five, "The Physiological Basis of Organismic Creativity," Gernot G. Falkner and Renate Falkner provide experimental evidence for the notion that living organisms are bearers of autopoietic creativity and homeostatic purposiveness. In interpreting the results of their studies on the phosphate uptake behavior of cyanobacteria in oligotrophic lakes, they employ several important concepts and terminology from Whiteheadian process-relational philosophy, such as "actual entities / actual occasions," "societies," "nexūs," "creativity," "concrescence," and "satisfaction." And based on these findings they further present speculative insights in relation to the role of self-creative purposiveness in the evolution of species, in the organization of multicellular organisms, and in embryonic development.

In Chapter Six, "Organismic Intricacy: Time, Possibility, and Nonrandom Heritable Novelty," Neil Dunaetz take on the aforementioned quest for a non-mechanistic language that is more conducive to the study of organisms than that which is presently employed in the life sciences. In so doing, Dunaetz takes a step beyond Whitehead by unpacking philosopher Eugene T. Gendlin's holistic and more contemporary *A Process Model* (1997 / 2017). In this endeavor, unique and creative concepts, such as "eveving," "focaling," and "interaffecting," which stem out of the need to reassess some our most "logical" assumptions concerning the temporal unfolding of living organisms and of evolutionary processes, are given expression.

In Chapter Seven, "Beyond Mechanism, Toward Re-Enchantment," Philip Tryon closes the volume by demonstrating that, based on the findings of contemporary quantum physics, there is great need for an event ontology, like that of Whitehead's, to be employed widely in the life sciences. Tryon not only points out the richness and efficacy of

Whitehead's event ontology, but he also raises some problems that may occur when employing the process-relational lens to interpret the natural world. Specifically, Tryon suggests that, going forward, a putative non-mechanistic, process-relational lens for the life sciences needs to better explain: (1) how present occasions can be related to all past events; and (2) how memory and instinct function without reference to memory and encoding forms, beyond Whitehead's appeal to a deity and his introduction of "eternal objects" into his conceptual scheme. Tryon analyzes several possibilities for finding solutions.

As evidenced by what has been said above and in the pages to come, the contributors to this volume bring a multiplicity of philosophical orientations to the table (e.g., process-relational philosophy, existentialism, Peirce, Gendlin, etc…) in challenging the contemporary beholdenness of the life sciences to the mechanistic and reductionistic neo-Darwinian paradigm. Mechanistic neo-Darwinism views nature and living organisms as "machines," namely, networks of externally related and linear causal "switches," "dials," "levers," "pulleys," and "gears," that are at the ready for technological and biotechnological manipulation. Seeking a conceptual framework and a language that are more adequate to the study of the natural world and of living creatures than the mechanistic orientation, the contributors of this volume explore several of the "New Frontiers of Biology," which, again, are areas of biology whose findings to some extent go beyond the explanatory confines of the Modern Synthesis of natural selection and genetics. Most notably, emergence theory, the theory of organic selection [aka "the Baldwin Effect"], epigenetics, homeostasis, chronobiology, and *autopoiesis* research can provide us with key insights into the emergence of living agents, including the nature of organismic mentality and the evolutionary origins of consciousness and mind. Moreover, attention to the "New Frontiers of Biology" can serve to "re-enchant" our understanding of the natural world and to prevent ecological devastation, through a restoration to objectivity of notions such as "intrinsic purposiveness," "selective agency," "creativity," and "intrinsic value."

7. The Origin of this Volume and Acknowledgments

The idea to put together this volume was raised collectively among the participants of the "Beyond Mechanism: The Emergence and Evolution of Living Agents" Session (Track 4, Section 4), which was part of the Tenth International Whitehead Conference—*Seizing and Alternative: Toward an Ecological Civilization* that took place at Pomona College, Claremont, California, USA, in June 2015. This "track" of the conference was organized and chaired by Adam C. Scarfe. Section IV: "Re-envisioning Nature; Re-envisioning Science" of the conference was overseen by Philip Clayton, while the conference as a whole was sponsored by the *Center for Process Studies* (CPS). Andrew Schwartz of CPS was primarily responsible for executing the meticulous vision of John B. Cobb, Jr., the conference's main organizer. Cobb, whose 2008 edited volume, *Back To Darwin: A Richer Account of Evolution*,[31] which was published by William B. Eerdmans Publishing Company, stands out prominently as an inspiration for the present generation of Whitehead-oriented thinkers to engage with the biological sciences and philosophy of biology. As we recall, a general theme of the entire conference of was getting "beyond mechanism" as part of resolving urgent problems, such as the global ecological crisis and the imminent financial crises to come. Indeed, Cobb remarked, "to see the world with ecological relations at its core means never to see it in the same way again."[32] As such, amidst the eighty-two tracks of the conference, it is clear that the themes of our track were at the very core of the entire proceedings.

As the title of our conference track suggests, the session took place in the wake of the publication of a previous co-authored volume entitled *Beyond Mechanism: Putting Life Back Into Biology*,[32] which was published by Lexington Books / Rowman & Littlefield in 2013 and co-edited by Brian G. Henning and Adam C. Scarfe. A central text for understanding the engagement of process-relational philosophy with the life sciences, this previous volume also had its origins at a conference hosted by the *Center for Process Studies* in Claremont, California in 2010. It presented a critique of mechanistic neo-Darwinism by showcasing the findings of the "New Frontiers" of biology and called for an "extended synthesis" in biology. As the present volume deals with very similar themes, in some sense, it can be considered as a sequel to *Beyond Mechanism*.

The authors and editor of this volume would like to thank their respective universities and institutions, as well as: John B. Cobb; Andrew Schwartz; Philip Clayton; David Ray Griffin; the *Center for Process Studies*; the *International Process Network*; Helmut Maassen (the editor-in-chief of Cambridge Scholars Press' *European Studies in Process Thought Series*); J. Scott Turner who participated in our track; Bogdan Ogrodnik, the President of the *Whitehead Metaphysical Society* in Poland, especially for his introduction of one of the co-authors of this Preface to Whitehead's process-relational philosophy and to the art of seeing nature through its lens; and all those scientists and scholars doing research in the

"New Frontiers" of biology, for their direct and indirect contributions permitting the emergence of this volume.

As the editor of this volume, there are two personal acknowledgments to make. First, I would like to thank my fiancée, Larissa McPhail, for her unwavering patience and emotional support during the period in which the manuscript of this volume was being prepared. Second, this volume is dedicated to the memory of my late father, Brian L. Scarfe, who lost a long battle with cancer in the months prior to the submission of the manuscript for publication.

Notes

1. Alfred North Whitehead, "Nature Alive" in *Modes of Thought* (New York: The Free Press, 1938 / 1966), 148-169.
2. Alfred North Whitehead, "Nature Lifeless" in *Modes of Thought* (New York: The Free Press, 1938 / 1966), 127-147.
3. See Whitehead's critique of "nature at an instant" in "Nature Lifeless," 145-146.
4. See Alfred North Whitehead, *Process and Reality: Corrected Edition*, eds. David Ray Griffin and Donald W. Sherburne (New York: The Free Press, 1929 / 1978), throughout.
5. Whitehead, "Nature Alive," 154.
6. Whitehead, "Nature Alive," 151.
7. See Whitehead's *Process and Reality*, throughout.
8. Whitehead, "Nature Alive," 161.
9. Whitehead, *Process and Reality*, 92, 99, 102. Also see Whitehead, "Nature Alive," 165.
10. Whitehead, "Nature Alive," 164-165.
11. Whitehead, *Process and Reality*, 20.
12. See Whitehead, *Modes of Thought*, 9, and 140.
13. Whitehead, "Nature Alive," 158.
14. Alfred North Whitehead. *Science and the Modern World* (New York: The Free Press, 1925 / 1967), 111.
15. Whitehead, "Nature Lifeless," 139. Touching base on the topic of epigenetics, and/or "Lamarckian" themes, Whitehead here states,

> when geneticists conceive genes as the determinants of heredity … the analogy of the old concept of matter sometimes leads them to ignore the influence of the particular animal body in which they are functioning. They presuppose that a pellet of matter remains in all respects self-identical whatever be its changes of environment. So far as modern physics is concerned, any characteristics may, or may not, effect changes in the genes, changes which are as important in certain respects, though not in others. Thus no *a priori* argument as to the inheritance of characters can be drawn from the mere doctrine of genes. In fact recently physiologists have found that genes are modified in some respects by their environment. The presuppositions of the old common sense view survive, even when the

view itself has been abandoned as a fundamental description.
16. Whitehead, "Nature Alive," 168.
17. Aaron A. Heiss, Giselle Walker, and Alistair G. B. Simpson, "The Ultrastructure of *Ancyromonas*, a Eukaryote without Supergroup Affinities," *Protist* 162 (2011): 373-393.
18. Heiss, *et al*. "The Ultrastructure of *Ancyromonas*."
19. Heiss, *et al*. "The Ultrastructure of *Ancyromonas*."
20. Everett E. Lund, "The Neuromotor System of *Oxytricha*," *Journal of Morphology* 58.1 (1935): 257-277.
21. Lund, "The Neuromotor System."
22. Lund, "The Neuromotor System."
23. Lund, "The Neuromotor System."
24. See George H. Wadhams and Judith P. Armitage, "Making Sense of It All: Bacterial Chemotaxis," *Nature Reviews—Molecular Cell Biology* 5 (December 2004): 1024-1037.
25. Frans de Waal, *Are We Smart Enough to Know How Smart Animals Are?* (New York: W. W. Norton & Company, 2016).
26. Frans de Waal, "Anthropomorphism and Anthropodenial: Consistency in Our Thinking About Humans and Other Animals," *Philosophical Topics* 27.1 (Spring 1999), 255.
27. See de Waal, *Are We Smart Enough?*
28. See Thomas Nagel, "What is it Like to Be a Bat?," *The Philosophical Review* 83.4 (October 1974), 435.
29. Whitehead, *Science and the Modern World*, 69-70. Also see Whitehead's *Process and Reality*, throughout, and his "Nature Alive" in *Modes of Thought* (New York: The Free Press, 1938 / 1966), 150-151.
30. Alfred North Whitehead, *Process and Reality: Corrected Edition*, eds. David Ray Griffin and Donald W. Sherburne (New York: The Free Press, 1929 / 1978), 241.
31. John B. Cobb, Jr., *Back to Darwin: A Richer Account of Evolution* (Grand Rapids, MI: William B Eerdmans Publishing Company, 2008).
32. See a description of the Tenth International Whitehead Conference here: http://www.ctr4process.org/occasions/events/conferences/conference/10th-international-whitehead-conference-9th-international-forum-ecological.
33. Brian G. Henning and Adam C. Scarfe, eds., *Beyond Mechanism: Putting Life Back Into Biology* (Lanham, MD: Lexington Books / Rowman and Littlefield, 2013).

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CHAPTER ONE

IS ENVIRONMENTAL PHILOSOPHY COMPATIBLE WITH MECHANISTIC NEO-DARWINISM?: ORGANISMIC AGENCY, INTRINSIC PURPOSIVENESS, AND THE "NEW FRONTIERS" OF BIOLOGY

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Abstract

The central problem that frames this chapter is the apparent incompatibility between: (a) some of the central themes in classical environmental philosophy (most notably, environmental epistemology and ethics), as exemplified by Paul Taylor's "The Ethics of Respect for Nature," and (b) neo-Darwinian biology, as exemplified by the thinking of Descartes, Huxley, Mayr, Dawkins, and Dennett, which embraces mechanistic reductionism as the chief method to study the natural world and living creatures. Here, I show how the former's emphases on concepts like "intrinsic purposiveness" and "intrinsic value," which are largely repudiated by the latter, become defensible if one takes into account what I call the "New Frontiers" of biology. Some of the areas that belong to the "New Frontiers" of biology include: the theory of organic selection (aka the "Baldwin Effect"), epigenetics, emergence theory, as well as homeostasis, chronobiology, and autopoiesis research. By providing criticisms of mechanistic neo-Darwinism with reference to several of these novel areas of inquiry, I argue, from a Whiteheadian perspective, for the intertwined theses that: (1) living organisms can be viewed as "agents of selection," rather than merely as objects upon which natural selection happens to act; and (2) organisms are bearers of "intrinsic purposiveness,"

a notion that can provide a foundation for the concepts of "intrinsic value" and "rights" that are typically emphasized in environmental philosophy and ethics. In arguing for these notions, key themes pertaining to the emergence and evolution of living agents, for example, organismic mentality and consciousness arising as functions of homeostatic, chronobiological, and autopoietic processes, are explored.

Keywords

Intrinsic and extrinsic purposiveness; organicism; holism; reductionism; mechanistic neo-Darwinism; intrinsic and extrinsic value; internal and external relations; anthropocentric humanism; biocentric anti-humanism; process-relational philosophy; the "New Frontiers" of biology; epigenetics; the theory of organic selection (aka "the Baldwin Effect"); homeostasis; chronobiology; physiological and mental autopoiesis; mentality; consciousness; living organisms as "agents of selection" / "loci of valuative-selective activity"; evolutionary neo-Kantianism; evolutionary neo-Hegelianism; geo-engineering; critical pan-selectionism.

1. Introduction: The Problem of the Logical Incompatibility between Environmental Philosophy and Mainstream Neo-Darwinism

Canvasing some of the major movements in environmental philosophy and ethics, such as "Deep Ecology," "Ecopsychology," and especially Paul Taylor's seminal essay, "The Ethics of Respect for Nature," the main problem that frames this chapter is whether some of the main concepts that are typically present in environmental philosophy are logically consistent with the basic conceptual framework that underpins mainstream neo-Darwinian biology. After all, in asserting their claims as to why human beings ought to embrace a biocentric outlook, and to act ethically in relation to their treatment of non-human organisms and the natural world so as to prevent the exacerbation of anthropogenic environmental problems (e.g., global warming and climate change, ozone layer depletion, air and water pollution, extinction of species, etc…), such movements in environmental philosophy have typically employed what some might assert are lofty metaphysical terms, such as "Self-Realization," "teleological centers of life," and "intrinsic value." These concepts are logically incompatible with contemporary neo-Darwinian evolutionary biology, which emphasizes a mechanistic conception of the world. As the reigning paradigm in mainstream evolutionary biology, the neo-Darwinian outlook emerged out of the Modern Synthesis, a development spanning the 1930s and 1940s and which saw to the merger of Darwinian natural selection and Mendelian genetics. Neo-Darwinism emphasizes concepts like "random gene mutation," "materialism," "mechanism," "reductionism," "determinism," "teleonomy," "biotic violence," "selfish genes,"[1] and "explanatory cranes over skyhooks."[2]

From a Lorenzian "evolutionary neo-Kantian" perspective, the meaning of the notion of "metaphysics" involves a reference to those indispensable concepts (such as "substance," "necessity," "causality," "self," "teleology," "mechanism") that, while not being derived fully from experience or warranted empirically, have had their mettle tested over eons of evolutionary time, such that they have been selected for. A keen biological predisposition toward them can be said to exist in the mentalities of rational beings. In a similar vein, Whitehead once defined metaphysics as "the science which seeks to discover the general ideas which are indispensably relevant to the analysis of everything that happens"[3] and he stated that "no science can be more secure than the unconscious metaphysics which tacitly it presupposes."[4] In that the life sciences employ at least some these notions (yet deny others), a thoroughgoing Lorenzian view would hold that biology presupposes metaphysics in this sense, and cannot divorce itself from the evolutionary context within which it takes place. Here, I make the case that environmental philosophy and mainstream neo-Darwinian biology provide incompatible pictures of the natural world and the organisms that live in, and help to compose it. However, attention to the "New Frontiers" of Biology, namely, to contemporary areas of biological research that to some extent go "against the grain" of the neo-Darwinian paradigm which emphasizes mechanistic reductionism, opens doors and windows to be able to resolve this lacuna. Some examples of the "New Frontiers" of biology include systems biology, emergence theory, the theory of organic selection (also known as the "Baldwin Effect"), niche construction, epigenetics, biosemiotics, homeostasis research, chronobiology, and autopoiesis research. Largely due to the advances made in these novel areas of inquiry, today, some biologists and philosophers of biology believe that there is need for a comprehensive reassessment of the foundational pillars of modern biology (i.e., natural selection and genetics), or at least of the rigidly reductionistic way in which they are applied in studying the natural world and life. Some have argued for the initiation of an "extended synthesis"[5] in biology.

While it can be maintained that natural selection is not implicitly a teleological process, but rather an "algorithmic" one (as Dennett says), the

"New Frontiers" of biology, taken together, demonstrate that living organisms can be viewed as "agents of selection" and bearers of "intrinsic purposiveness," rather than merely as objects upon which natural selection happens to act. The notions that living organisms are bearers of "intrinsic purposiveness," is an idea that neo-Darwinism deems to be of the realm of "the metaphysical" (theologically construed) and hence, largely inadmissible in scientific research. However, the restoration of this notion with reference to the "New Frontiers" of biology can provide a conceptual foundation for the claims of environmental philosophy and ethics that: (1) living organisms have "intrinsic value"; and (2) "rights" can be attributed to them.

2. Paul Taylor and Deep Ecology: Teleology and Intrinsic Value

I start with the anti-anthropocentric arguments of Paul Taylor, as contained in his classical essay in environmental philosophy, entitled "The Ethics of Respect for Nature" (1981).[6] In making his case as to why one should adopt a biocentric outlook, as opposed to the anthropocentric one, Taylor uncovers what he feels are some of the chief sources of anthropocentrism in Western culture. As one of these sources, Taylor critically scrutinizes Aristotle's highly anthropocentric statements in the *Politics* that

> plants exist for the sake of animals and animals exist for the sake of man, tame animals for the use he can make of them as well as for the food they provide; and as for wild animals, most though not all of these can be used for food or are useful in other ways; clothing and instruments can be made out of them. If then we are right in believing that nature makes nothing without some end in view, nothing to no purpose, it must be that *nature has made all things specifically for the sake of man*.[7]

In the essay, Taylor challenges Aristotle's belief that Nature is to be viewed as a mere instrument for the fulfillment of human purposes. Taylor argues that such a one-sided view of the relationship between Nature and humanity enables the promotion of ecologically destructive activities, namely, those that contribute to ecological problems like global warming and climate change; ozone layer depletion; the extinction of species; air, water, and soil pollution; and overpopulation. However, while profoundly critical of Aristotle's anthropocentrism, Taylor borrows from Aristotle the concept of "teleology" in order to build his case that human beings ought to embrace lifestyles that respect non-human organisms and the natural world.

As Taylor notes, the meaning of the Greek word *telos* implies "purposiveness," "goal-," or "end-" directedness." According to Aristotle, Nature is a purposeful, rational, and orderly system in which every organism is engaged in a teleological movement from potentiality to actuality. For example, in the context of their teleological life-process of growth, development, and differentiation, providing that they have adequate nutriment and water conditions, acorns become oak trees and tadpoles transform into frogs, rather than into water buffaloes. Similarly, human embryos develop into fetuses, fetuses into babies, babies into children, children into adolescents, adolescents into adults, and so forth. They do not turn into giraffes. The Aristotelian premise that organisms unfold teleologically enables one to classify organisms into groups, as in scientific taxonomy, as well as to predict through inductive reasoning what, basically, an immature form of a creature will become as it grows and matures. Aristotle classified human beings as "rational-souled" creatures, as opposed to "vegetative" (e.g., plants and trees) and "sentient" beings (e.g., non-human animals). Unlike the latter, for human beings, the teleological process is not only considered to be physiological, but also intellectual, as exemplified by their learning, their gaining of knowledge and wisdom, and their pursuit of life-goals in the context of society. For Aristotle, human beings should not do that which thwarts the teleological process, either in oneself (e.g., committing suicide, becoming addicted to drugs, or having an eating disorder), or in other persons (e.g., committing acts of murder, theft, or adultery). Furthermore, for Aristotle, one ought to cultivate the habit of embracing a virtuous Golden Mean beyond excess and deficiency in respect to our actions, so as to heighten our chances of attaining *eudaimonia*, namely, a state of ecstatic happiness or flourishing, or of living a good life in the deep philosophical sense.

Appropriating from Aristotle's philosophy of Nature and his virtue ethics, in building his environmental ethic, Taylor asserts that both human and non-human organisms are to be considered *teleological centers of life*[8] having *intrinsic value*, whose unfolding should be respected. In so doing, Taylor extends the application of Aristotle's ethical principle of non-maleficence beyond humans so as to include non-human organisms. He does so by suggesting that human beings have a *prima facie* duty (i.e., not an absolute obligation) to refrain from thwarting their teleological process or from inflicting undue suffering onto them. In building his arguments for the claim that non-human organisms are *teleological centers of life* that, like members of the human species, have intrinsic worth and are deserving of respect (and perhaps even "rights"), Taylor draws upon the findings of the science of ethology to argue that non-human organisms have unique perspectives on the world, they have a good unto themselves that they strive for, they preside over their own lives, they value various things in their environment, they have unique individualities, they engage in unique behaviors, and they are irreducible, compositional parts of the complex interdependent system that is Nature. While Taylor mentions organismic *homeostasis* in his essay,[9] he does not provide an analysis of how this important scientific notion can help to provide him with a ground for his claims that living organisms are "intrinsically purposive" and have "intrinsic value."

For Taylor, it is because organisms are teleological centers of life that non-human organisms should be seen by human beings to have *intrinsic value*, rather than merely having instrumental value for them, and that they should *prima facie* be respected. In the essay, Taylor does not go so far as to argue that they should be accorded the protection of legal rights, for example, against undue suffering at the hands of human beings, but he asserts that he is open to this possibility. Taylor's claim that non-human organisms have intrinsic value is also shared by many other classic environmental movements such as Deep Ecology[10] and Ecopsychology,[11] as well as by animal rights deontologists, like Tom Regan, who in *The Case for Animal Rights* (1983), characterizes organisms as *subjects-of-a-life*.[12] Furthermore, in *Science and the Modern World* (1925), Alfred North Whitehead criticized the diminishment of the sense of the intrinsic value of living organisms that comes with modern biology's alignment with Descartes' substance metaphysics and its emphasis on mechanistic reductionism.[13] Yet, in articulating their arguments for the notion that both human and non-human organisms are creatures that unfold teleologically and have intrinsic value, none of these sources do much to show how their views are compatible with mainstream neo-Darwinian evolutionary biology at all. Neo-Darwinism interprets non-human organisms, and increasingly, human beings, as "machines" that are designed by the non-purposive, algorithmic process that is natural selection. For neo-Darwinism, notions such as intrinsic purpose and intrinsic value are metaphysical and largely inadmissible. Furthermore, for neo-Darwinism, there is no conscious and/or purposive selective agent that decides which organisms are to be preserved and which are to be eliminated in the struggle for existence. Rather, evolution is said to involve random mutation and/or the indeterminate distribution of genes. Teleological views, in which it is postulated that organisms are bearers of "unseen inner drives" were purged from biology's Modern Synthesis of Darwinian