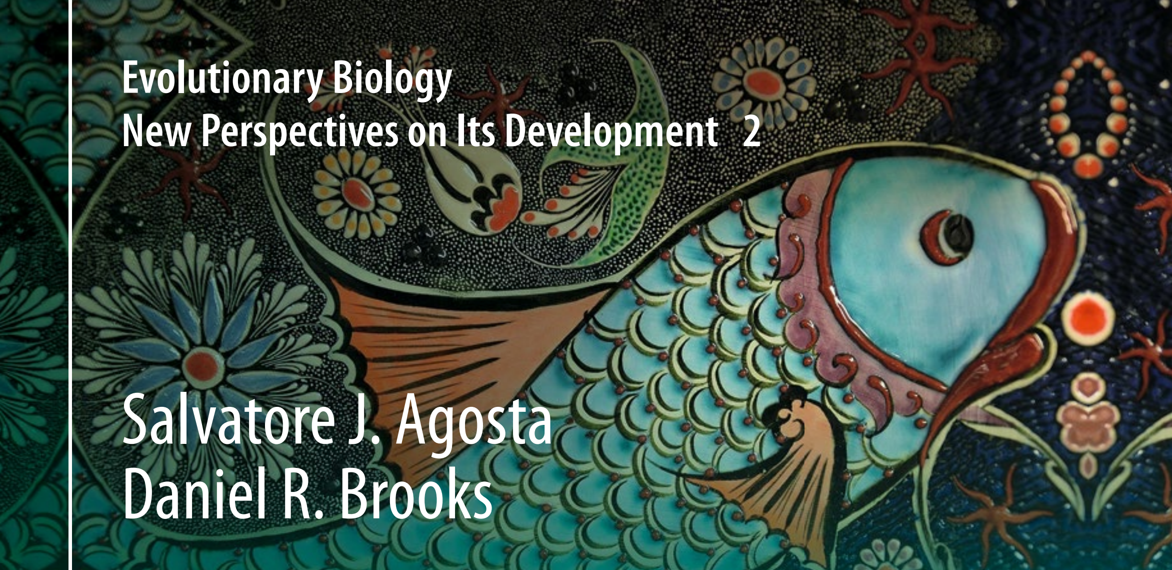

Evolutionary Biology
New Perspectives on Its Development 2

Salvatore J. Agosta
Daniel R. Brooks

The Major Metaphors of Evolution

Darwinism Then and Now

Springer

Evolutionary Biology – New Perspectives on Its Development

Volume 2

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Darwinism Then and Now

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This book is dedicated to the memory of John Collier, who not only worked through and resolved many of the conceptual quagmires we wandered into, but who also set a standard of intellectual pursuit always in the context of an ethical life. We hope he would have largely approved of our efforts, and we think he would have been one of the first to begin the job of improving upon the platform we present herein.

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Salvatore J. Agosta and Daniel R. Brooks

I began devouring books about evolution when I was a teenager. This book represents the culmination of a 30-year journey that started then, marked by the influence of too many people and places to name. Special thanks to Mike Steele (Wilkes University), Joe Bernardo (Texas A&M) and Art Dunham (University of Pennsylvania) for their outstanding mentorship and personal friendship along the way. Thanks also to Dan Janzen (University of Pennsylvania) for introducing me to the Area de Conservación Guanacaste, Costa Rica, and the wonders of tropical field biology and for fostering key ideas that led to the evolution of this book. And most of all, special thanks to my co-author Dan Brooks for being an outstanding mentor, colleague and friend. Quite simply, his impact on my career has been enormous, and I am extremely proud and grateful of the opportunity to write this book together.

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Daniel R. Brooks

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Chapter 1
Context

Abstract The unifying principle of Biology is that all life is evolved life. As part of science's social contract, the main goal of Biology should be to "put evolution to work" for humanity, which is currently facing existential threats stemming from the combination of overpopulation, globalized trade and travel, urbanization, and widespread environmental change. These are all complex phenomena involving living systems, putting Biology and its central theory at the forefront of efforts to deal with the problems they cause. Now more than ever, we need a coherent operational evolutionary theory that works for humanity. To accomplish this, we argue, requires a return to Darwinism to recover useful but discarded ideas and to extend it forward while removing barriers between specialized areas of research to integrate new ones.

This book is a contribution to the series *Evolutionary Biology: New Perspectives on its Development*. The editor of the series founded it to encourage a forum for biologists, historians, and philosophers to express ideas in an effort to form a coherent narrative for evolutionary biology. We are pleased to be able to contribute to the series. We believe humanity faces an existential threat stemming from the complex and intertwined phenomena of global climate change, overpopulation, global trade and travel, and increasing urbanization. These phenomena are all produced or influenced by living systems and affect the lives and futures of living systems, and Biology is increasingly the focus of efforts to cope with them. The unifying principle of Biology is that all life is evolved life, yet too few proposals for safeguarding the future of humanity invoke evolutionary principles, and most of those that do emphasize stasis, not change and diversification.

Humanity seems to have a love–hate relationship with evolution. Many scientists study evolution in a manner that would allow them to control, to engineer, the process. Conservationists want evolution to be a matter of equilibrium-based cycles because they think such cycles are perpetual motion machines that can be controlled, despite evidence of massive episodic disassembly and reassembly of ecosystems throughout history. Genetic engineers, especially those in the agricultural sciences, want infinite food production for an infinitely growing human population. Evolution, however, seems to place limits on our ability to accomplish whatever we wish, and

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many scientists chafe at this. Finally, some think that our technological development has removed us from the arena of evolution.

Cosmologists are often in error but never in doubt—attributed to Lev Landau

The Enlightenment created a social contract in which scientists were supposed to understand nature and its laws in order to control them for the betterment of humanity. But such humanitarian impulses, religious and secular, did not result in our attempting to learn to live within our means. Rather, the Enlightenment gave our species permission to be a species of cheaters. We want to cheat on the laws of nature; we want endless energy for free; we want perpetual motion machines; we want to go faster than the speed of light; we want to live forever; we want beautiful children; and we want all of it for free. Physics has promised all that and more.

Biologists think differently than physicists—different kinds of people are attracted to the different disciplines and their training reinforces those interests and propensities for seeing the world. Many things that biologists take for granted as fundamental truths have preoccupied physicists and philosophers for centuries. Biologists tend to understand and accept complexity more easily than physicists because their subject matter is inherently more complex. Physicists operate in a world of relative simplicity in which the fundamental units are generally homogeneous (if you have met one electron, neutron, proton, hydrogen atom, water molecule, etc., you have met them all) and where a comparatively small number of principles can be used to explain the things that happen to them. Biologists operate in a world in which the fundamental units (genes, organisms, populations, species, ecosystems, etc.) are highly heterogeneous due to unique inheritances and histories of interacting with the environment. For biology, the "average individual" does not exist—even clones are not identical (Cepelewicz 2020). This makes it less fruitful to describe things using the "law of large numbers" that makes the elegant difference and differential equation approach of describing physics so successful. Biology is an emergent property of physics and chemistry and therefore exceedingly more difficult to explain. All of the patterns and processes in biology are the result of many simultaneous and potentially interacting factors most of which are scale-dependent (Quinn and Dunham 1983), so the domain of generality in describing any given part of biological systems becomes extremely limited (Dunham and Beaupre 1998). Biologists are preconditioned to *expect* that everything will be complex. And yet, one product of the Enlightenment is that certain topics are considered the exclusive property of physics, while no topic is outside its scope. In 1827, for example, the British Botanist Robert Brown described an interesting phenomenon about the movement of pollen of *Clarkia pulchella* immersed in water (Brown 1828). Almost 80 years later, Albert Einstein published an article in which he translated Brown's almost poetic prose into the cabalistic incantations of physics (Einstein 1906). Einstein's explanation of *Brownian motion* served as convincing evidence that atoms and molecules exist and helped build his career. In 1908, Jean Perrin provided experimental confirmation of what was by then considered to be Einstein's theory (Perrin 1909), for which he was awarded a Nobel Prize in 1926.

We know of one notable exception to the directional flow of epistemic trespassing from Physics and Chemistry into Biology. In our experience, nothing makes physicists more apoplectic than for biologists to mention the word *entropy*. And yet, in a public presentation in Leipzig in 1905, Ludwig Boltzmann said that Darwin had established the initial framework for a statistical mechanics of biology. Boltzmann also said that the one place he disagreed with Darwin was that he felt the struggle for survival was actually a struggle for entropy (Broda 1983). It was Boltzmann, therefore, who gave biologists permission to discuss evolution as an entropic phenomenon.

We believe it is important to rediscover the richness of the past in evolutionary biology, not just in terms of insights gained, lost, and discarded, but also more literally. If all life on this planet is evolved life, then the past is the prologue for all its narratives. Providing a common basis for a coherent narrative demands that we remember (and in some cases rediscover) the reservoir of useful ideas proposed during the last two centuries while removing barriers between specialized areas of research to effectively integrate new findings and insights. As part of science's social contract, the ultimate goal of evolutionary biology should be to create an operational framework to "put evolution to work" for humanity, to make it a theory that matters. We cannot accomplish this task by rehashing old ground, by arguing about semantics, or by leaping from one shiny object to another as the next "new idea" appears and someone decides it is the monolithic answer to all real and perceived shortcomings in existing views about evolution.

We have a single goal in mind—making the conceptual framework of evolutionary biology stronger and more useful to humanity in a time of existential crisis. At the same time, we understand that the conceptual realm for evolutionary biology is extensive and complex, comprising all areas of biological research as well as elements of physics, chemistry, and anthropology. As a consequence, we realized that a useful framework for beginning multiple conversations leading to that hoped-for common narrative needed a highly abstract metalanguage. That abstraction will lead us to veer outside the accepted academic boundaries within which we were trained. And this will inevitably lead some to accuse us of that sin of *epistemic trespassing* (Ballantyne 2019; Bristol and Rossano 2020). We think that would be wrong. We will borrow liberally from outside our training, but we are not trying to tell anyone "out there" how to do their jobs. Rather, we think we can learn from each other and generalize our knowledge as a result of peering into someone else's backyard to see if they have developed ideas that can help us. And when that happens, why should we not extend the range of those ideas and acknowledge where we got them?

> Origin of man now proved—Metaphysic must flourish—He who understands baboon would do more towards metaphysics than Locke—Charles Darwin (1838)

David Hull (1988) was the first person we encountered who actively embraced and combined history, philosophy, and sociology, weaving stories about a range of people involved in scientific controversies into his narrative account of the dynamics of science. Luckily for us, he focused on evolutionary biology rather than physics or chemistry. Hull's findings differed from the wildly popular notion of paradigm shifts espoused by Thomas Kuhn (1962), which treated change in scientific theories as exemplars of intergenerational conflict. If you do not like the Old Guard's ideas, just wait, they will die and you can take over (until you die). But Hull et al. (1978) found that one's age—*Planck's Principle* (Planck 1950)—had little to do with acceptance or rejection of Darwin's theory. Agreement or disagreement with the basic principles mattered a lot. But so did something else, something very human.

Hull discovered that the one thing of paramount importance to scientists was the one thing they themselves often failed to do. And that is a matter of respect—time and again, the scientists Hull interviewed said the most important thing to them was to be acknowledged for their original contributions—no matter how small. And yet, time and again, Hull discovered that in the published research of those same scientists, they often failed to give credit where credit was due. First and foremost, they gave credit where credit would help their careers the most, even if others had published the ideas previously. And feeling that you have been dissed is age-independent. Hull believed that this created the tension within scientific communities that Kuhn mistook for intergenerational conflict. Hull then suggested a positive aspect of such an unpleasant system—if you live in an environment full of people out to get you or looking for a reason to ignore your work, you will be extra careful with your own work. So, Hull reasoned, science is full of nasty people because the need to be factually correct outweighs the need to be polite. Needless to say, when his book appeared, Hull was attacked bitterly for painting a negative picture about how bitterly scientists deal with each other on a personal level. At some point, the attacks stopped, perhaps because the attackers realized that the more aggressive they were, the more Hull's basic thesis seemed sound.

No doubt some studied Hull's book for clues on how to be successfully aggressive, and no doubt many were helped in their career aspirations. At the end of the twentieth century, much—though not all—of the history and philosophy of Biology was geared toward describing, justifying, or celebrating the inevitability of a paradigm that many who extolled its virtues also recognized as flawed and incomplete. The historians and philosophers of biology during the past 50 years have tended to describe the discipline as passing through a few key phases: Darwinian Revolution; Eclipse of Darwinism; Evolutionary Synthesis; Expanded Evolutionary Synthesis. More recent analyses take the perspective that those phases are not so much objective mileposts as social constructs created to frame an intellectual and institutional agenda emphasizing key people rather than key contributions (e.g., Delisle 2008, 2011, 2019 and references therein).

This led a new generation of historians and philosophers to begin asking different questions. Interdisciplinary conferences sprang up, examining evolution within the context of topics never previously associated with evolutionary theory: closure, complexity, entropy, information, irreversibility, self-organization, systems theory (e.g., Weber et al. 1988; Van de Vijver et al. 1998; Chandler and Van de Vijver 2000; Taborsky 2000; Capra et al. 2010), all participants having a wonderful time in a merry ferment of epistemic trespassing. There was no doubt that the end of the twentieth and beginning of the twenty-first century were periods of enormous empirical and conceptual output. Nonetheless, some began to ask pointed questions about the official pantheon of the twentieth century evolutionary biology, specifically questions about what colleagues they might have trampled on their way to the top, and what interesting ideas they might have ignored and suppressed along the way. Everything was being questioned, sides were being taken and battle lines drawn, leading to a fragmentation of the biological sciences at precisely the time unification was needed most to confront the anthropogenic alteration of the biosphere, most notably the threat of global climate change, as well as the profound ethical issues associated with biotechnology. John Collier (2000) spoke for an emerging sensibility within history, philosophy, and sociology of science at that time when he posed the question, "Is there any virtue in modern science?" Less than a decade later, Alicia Juarrero (2008) suggested that professional philosophy needed a "To Re-think" list, focusing on causality, explanation, and ethics. We hope our contribution to this series will help advance that agenda.

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Chapter 2
A Talking Book

Abstract Evolutionary biology is in conceptual disarray at a time when humanity cannot afford it. Never have we had more information and less integration. As well, the current consensus framework has failed substantially to provide guidance in the face of accelerating global climate change. We hope to provide an arena within which all interested people can contribute to unifying the disparate perspectives into a comprehensive theoretical framework leading to a more robust approach to ensuring humanity's future. We are by nature fearful, storytelling, dreaming beings. For the arena to be maximally inclusive, we rely on narrative approaches grounded in metaphors.

> There is another form of temptation, even more fraught with danger. This is the disease of curiosity… It is this which drives us to try and discover the secrets of nature, those secrets that are beyond our understanding, which can avail us nothing, and which man should not wish to learn—St. Augustine

Let's talk.

All living systems on the planet are linked together by a single evolutionary history. This is the unifying principle of biology, and it has guided an enormous amount of basic research that enhanced our understanding of the origins of biological diversity and the way it has coped with adversity since the origin of life more than 3 billion years ago. That understanding has led, in turn, to substantial contributions to human civilization, notably in the areas of food production and health, and more recently in advancing our awareness of the existential threat created by global climate change.

Ironically, evolutionary biology in the first quarter of the twenty-first century has never had more data and less integration. There is a consensus framework, but it has been buffeted by criticism broadly and consistently for half a century. Among the critics are many people with interesting perspectives, but to date, there is no platform that allows all of them to have a voice. The result is a fragmented and fractious group of scientists, each composed of highly intelligent people well acquainted with the empirical findings of their narrow specialty, all arguing that the rest of the biological world should be explained in terms of what they know. This is due, in large part, to

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the early twentieth century emergence of specialized and canalized research programs focusing on pieces of a puzzle. As in the parable of the blind men and the elephant, people study only their particular discipline and do not ask how it might connect with data from another.

It is generally in the best interests of scientific development to have a common platform, even if it is not a universally agreed-upon framework (though most would agree this is a worthy goal). We thus think it is mildly embarrassing that the unifying theory of biology is so disunified. But we are not surprised; this is academic business as usual when an important conceptual framework is concerned. The natural history of humans in general is complex and messy. Conflicts of interest occur among humans easily and often, and scientists never escape their basic humanity. As a result, scientists are notoriously ill-mannered and intolerant when it comes to new ideas, except their own.

> A scientist will never show any kindness for a theory which he did not start himself—Mark Twain (1880)

More importantly, we find it unconscionable that the unifying theory of biology has been so poor at anticipating, coping with, and producing proactive recommendations relative to global climate change. The global climate change that is rapidly accelerating and bearing down on a largely unprepared humanity has a substantial biological, and thus evolutionary, basis. We strongly believe that the consensus framework that dominated the twentieth century largely failed to anticipate the various evolutionary implications of global climate change or offer effective solutions. Evolution has been the only process to regenerate the biosphere following a mass extinction event, and evolution has never failed in that regard. Despite this, most policies in conservation biology consist of programs designed to stop evolution at all costs and promote a nostalgia for a static past that never existed. As humanity faces an existential threat coming at an accelerating pace, we must expand and enrich evolutionary theory. We think many recent perspectives on evolutionary theory have something to offer toward that goal. The advocates of those perspectives, however, must accept that they are like the blind men examining an elephant. It will require many to make this new framework coherent, to truly understand what an elephant is.

We think a unified, coherent, and above all useful evolutionary framework is within our grasp, but we have not had a metalanguage to allow helpful communication among specialized research programs. That is the primary purpose of this book. Three basic aspects of human biology underly our effort to produce such a metalanguage.

2.1 We Are a Fearful Species

> I must not fear. Fear is the mind-killer. Fear is the little-death that brings total obliteration. I will face my fear. I will permit it to pass over me and through me. And when it has gone past I will turn the inner eye to see its path. Where the fear has gone there will be nothing. Only I will remain—Frank Herbert (1965).

In order to understand how we think about a concept like evolution, and why there is such a diversity of aggressively held views, we have to understand some critical things about our own evolutionary legacy. We are a cautious, fearful species, and we come by this fearful nature honestly, that is, evolutionarily. We are descended from prey and the life of prey is founded on fear (Brown et al. 1999; Laundre et al. 2014; Bleicher 2017). Anyone who has seen primates in the wild understands this. Faced with known predators, or animals of unknown capabilities and intent (like biologists), primates freeze and assess, then flee if the potential threat does not quickly move along. We began as Man the Hunted, descendants of primates whose cleverness, combined with caution and suspicion, allowed us to survive long enough to begin making the weapons evolution neglected to provide. Once we successfully tested those weapons on species that recently had been fellow prey, we styled ourselves Man the Hunter. But there is one thing that still scares us all.

2.1.1 The Complexity Paradox

> Paradoxes offend reason and are therefore a reason to laugh—Umberto Eco (1983).

> How wonderful that we have met with a paradox. Now we have some hope of making progress—Niels Bohr (quoted in Moore 1966)

The fragility of early hominids placed a premium on accurately perceiving and generalizing the complexity of their surroundings—underestimate it and you are lunch, overestimate it and you starve. Evolution worked well for us in that regard; self-awareness brought with it an excellent ability to perceive complex patterns and to accurately assess the complexity of our surroundings. But self-awareness also produced a paradox: if we are good at accurately assessing complex patterns in our surroundings, why are we so afraid of complexity? The answer is that successful generalizing of our surroundings gave us a sense of security, so we trusted it—good became synonymous with generalization, evil with contingency, the complexity that cannot be generalized, that frightens us and does us harm. We distrust complexity because that is where the saber tooths, cave bears, and boogeymen are.

> Men always fear things which move by themselves—Frank Herbert (1969)

Given the recognition of complexity in the world and our fear of it, self-awareness had to be linked to psychological denial in order for us to continue to exist in a world made dangerous by that complexity. But, like all evolutionary innovations, denial has costs as well as benefits. Denial can keep us from responding assertively to threats in our surroundings that we perceive (Dor-Ziderman et al. 2019). We are so afraid of the complexities of an uncertain tomorrow and the certainty of death that we invented a universe that we can control as soon as we have accumulated enough knowledge about it. Western philosophy of science has been based entirely on the belief that nature is fundamentally simple, and any appearance of complexity is our fault—the result of incomplete information.

And yet, all of our experience tells us that we live in a complex world, not a poorly known simple one, and the more we learn about it, the more complex it becomes. We know it is a universe structured in such a way that we can control only limited amounts of our existence, and that makes us unhappy and resentful. This is why proximal explanations have always been more comfortable and familiar to humans, while ultimate explanations have tended to be a little frightening. This sense of fear is incorporated into our equating "ultimate explanations" with "final causes," truly a scary thought. Following this tradition, the Nobel laureate chemist Ilya Prigogine associated our understanding of the open universe as the "end of certainty" (Prigogine 1996).

The realities of the twentieth century have forced scientists to confront the natural complexity and to produce theories that are consistent with observations. We are so afraid of complexity that we keep wanting to (over)simplify, even if it is not helping. Like our remote ancestors, we think complexity is dangerous and frightening.

> . . .Rulag was an engineer, and he had found in her the engineer's clarity and pragmatism of mind, plus the mechanist's hatred of complexity and irregularity—Ursula LeGuin (1974)

We evolved in a world of patterned complexity, and all of our empirical experience of the world as we grow up reinforces that. The more we learn the more complex the world becomes, and yet we are still able to function; in fact, we function quite well in complex situations. The world is neither chaotic nor simple.

Depending on our personalities, our surroundings either scare us into denial or intrigue us to investigate their true nature. What do we hide from?—our fears. What do we fear the most?—the unknown. And yet, we claim to be explorers of the unknown. Most often, however, we want the unknown to be only a little unknown and ultimately controllable. We do not like big surprises.

Darwin was not afraid—the complexity excited him. And that is what allowed him to formulate the first scientific theory based on principles of complexity. What separated Darwin from most of his contemporaries, and from most of those who have followed, was his ability to accurately assess the complexity of evolution and not be afraid. He did not try to rationalize reality so it would no longer be fearful. Darwin saw great beauty as well as great tragedy in evolution, and he produced a pragmatic theory. He showed us that we do not need certainty to survive and to thrive. Despite his example, we are still largely in denial about his fundamental insight, that life on this planet is evolvable and that evolution is a complex phenomenon. We have begun to accept that this is true, but we are uncertain about what this means and what we ought to do in the face of the greatest imminent threat to humanity, global climate change. A tennis adage is "never change a winning game, always change a losing game." We are playing a losing game with respect to global climate change, and we cannot change that unless we admit it, but we do not want to. Complexity makes us afraid, and fear catalyzes denial, leading us to continue doing what we have been doing, even though it is not working.

We need to be able to overcome our fears if we are to work together. Fortunately for us, the origin of human language provided us with a means of doing both. We believe that sharing information through storytelling can help us achieve a common platform where everyone can learn, and humanity can extend itself into the future. Complexity defies prediction and so some of it will always appear mysterious. Parts can be expressed in the form of a narrative, because narratives simulate the flow of time, carrying the lessons of the past and projecting aspirations for the future. There have been many unpleasant events in evolutionary history, but there is an unbroken record of survival. Life is resilient and persistent.

2.2 We Are a Storytelling Species

> It is shocking to find out how many people do not believe they can learn, and how many more believe learning to be difficult... every experience carries its lesson—Frank Herbert (1965)

Our evolutionary legacy as social primates produced the complexity paradox and a means of coping with our fears of the complex unknowns of the world. One of the benefits of the origin of language was the ability to share information and to learn from each other. Huddled in small groups around a sputtering flame, gathered boisterously in a royal hall at banquet time, assembled solemnly in a religious convocation, or simply in pairs of parents and children, humans have long known that important lessons are best taught through narratives (Sugiyama 2001). The most important of those lessons have always been cast as narratives anchoring the great lessons in past times and places, even if mythical. These *historical narratives* can be legends or sagas. Legends, stemming from the Latin *legere*—"to read, gather, select"—are written compositions meant to be repeated in storytelling without change. Sagas, from the Old Norse *saga* and Old English *sagu*—"a saying"—are narrative compositions meant to be adapted to changing audiences over time and space. The intentionally flexible nature of sagas is the reason we tend to believe that written histories are more accurate than oral histories, even though this is often not the case. An incorrect written record is incorrect forever; a saga, no matter how often it is modified, may retain essential truths.

Storytelling is a form of social cooperation, so we can tell a story from different perspectives and still see that it is the same story. By blurring the distinctions between subjectivity and objectivity, narratives allow us to learn more easily, feeling less coerced. They play an essential role in science (Norris et al. 2005). Good narratives attempt to explain as well as describe the world, to give insights—*we never anticipated this particular thing, but we can explain it.*

> As a philosopher living in a post-modern world, I have come to accept that narratives have a power that despite all the literature on the subject I cannot quite put my finger on, a power that manages to accomplish what nonfiction explanations and accounts simply do not: a kind of integration between seemingly irreconcilable and incommensurate voices. I have grudgingly come to believe that stories might even be a better tool than nonfiction at conveying the incompressible complexity of the human element. Plato, of course, knew this early on: When the going gets tough in any of his dialogues, the old Greek always resorts to a story to get his point across—Alicia Juarrero (1999)

We are trying to create an environment for discussion that allows people to wander among different frameworks in a way that allows them to discover common perspectives that may be obscured by the use of diverse nomenclature. We are not trying to create an echo chamber, telling the story as a legend word for word to maintain group cohesion. Rather than telling a story about how things were, are, or should be, this will be more like telling a story about how to tell the story. This is the beginning of a saga, one that we hope will persist, grow, and change through time as it is told by a growing number of people.

> . . .during our whole journey, I have been teaching you to recognize the evidence through which the world speaks to us like a great book. Alanus de Insulis said that *omnis mundi creatura quasi liber et pictura nobis est in speculum*. . .But the universe is even more talkative than Alanus thought, and it speaks not only of the ultimate things (which it does always in an obscure fashion) but also of closer things, and then it speaks quite clearly—Umberto Eco (1983).

2.2.1 A Story Within a Story

> In the beginning was the Big Bang, and that was a very long time ago. This is just a reminder of this evening's extra performance. . .In brief, the encore revolves around the creation of the performance's audience. . .Seats are still available. . .The applause for the Big Bang was heard only fifteen billion years after the explosion. . .—Jostein Gaarder (1999)

We believe that setting the stage for productive discussions among many different biologists by telling stories is particularly apt for biology. Living systems are capable of acting on their own behalf but, more importantly, they regularly take the initiative—life has a life of its own. And they do this primarily through capacities to cope with their environments that they have inherited. Also, the nature of inheritance is so conservative that most explanations for how organisms look and how they function today are rooted in persistent history. In the fifteenth century, poets and natural philosophers were content with the idea that history is a dead record of the past, having nothing to do with the present or future (Huizinga 1996). Darwin changed all that.

Evolution, therefore, is a journey, not a destination, a game not a victory; it is a never-ending story in which the participants not only play the game, they change the rules and the dimensions of the playing field from time to time. It is an interwoven collection of many stories involving common times and common places, each with one narrator and many commentators. Our narrative approach to talking about evolution, therefore, is telling the story within a story.

2.3 We Are a Dreaming Species

> Life isn't a problem to solve, but a reality to experience. . .A process cannot be understood by stopping it. Understanding must move with the flow of the process, must join it and flow with it. . .What senses do we lack that we cannot see and cannot hear another world all around us?—Frank Herbert (1965)

We are not just a fearful storytelling species, cowering in the dark. Sleeping and awake, we are a dreaming species. Despite our fear of the unknown, we simply cannot stop dreaming. We do not seem to be able to resist the urge to embellish our stories of what happened with ideas about why it happened and what might happen in the future. It is in our dreams that we seek insights. We think about our dreams and worry over them. When we try to incorporate our dreams into our conscious lives, we become symbolic storytellers and generalize using metaphor. When some of those metaphorical narratives point the way to living truths, we call them scientific theories.

> The question, in fact, was whether metaphors and puns and riddles, which also seem conceived by poets for sheer pleasure, do not lead us to speculate on things in a new and surprising way, and I said this was also a virtue demanded of the wise man—Umberto Eco (1983)

Our best stories come from our dreams and are inspirational and aspirational, not merely operational. When we share our dreams, we speak metaphorically, whether we are aware of that or not. So, when we resort to metaphors, we are talking about our aspirations and fears, the dream world where our understandings and our beliefs come together (Coward and Gamble 2010).

> You see things; and you say "Why?" But I dream things that never were; and say "Why not?"—George Bernard Shaw (1921)

Scientists use two kinds of language: nomenclature and metaphor. The technical language of nomenclature attempts to eliminate ambiguity in concepts and entities within an established area of science. An excellent example in Biology is the use of scientific names for species. If a North American and a European call a bird a "robin," they are referring to two different species that are not closely related. Common names invite speculation and investigation; they are metaphorical. If, however, both say *Turdus migratorius*, there is no confusion. Choosing a "dead language" for formal nomenclature helps preclude additional meanings creeping into the nomenclatural designations.

Nomenclature can mean we know what we are talking about and we want no ambiguity. It can also mean we have no idea how to solve a problem so we will simply make up terms and hope somehow an answer will come to us. Making up new terms, giving new names to old phenomena, is a way for scientists to try to quell their fears of failure. But terminology never solves problems. Professional nomenclature is used to formalize objects and to provide internal cohesion among research groups. This is an exercise in mapping of static objects and relations. Biology is full of labeling language and much of it is in Latin because a dead language creates no new connotations or metaphors. Nomenclature is also used to eliminate metaphors because it wants to eliminate connotations and ambiguity (e.g., choose a dead language to name species rather than common names in various living languages). So, none of this can tell a story. Labeling does not allow you to judge, assess, or learn about yourself. It leads inevitably to iconotropy, pointless battling over the proper definition of a term.

Scientists who are comfortable with a given normative framework tend to embrace nomenclature as the solution to problems, which they see as mostly a matter of reducing ambiguity within the framework. Appeals to nomenclature will never lead to new insights, no matter how much basic information is obtained.

Scientists defending a conceptual framework tend to mistrust metaphors because they allow too many possibilities, thus introducing ambiguity into the framework. Metaphors may also be emotion-laden, and scientists who do not know how to integrate reason and emotions distrust them.

The essence of science is change, however, and scientific change is creative. When there is a need, or desire, to make a change in a normative framework, therefore, metaphor becomes the language of choice. Perhaps the most important function of metaphor in science is in extending existing nomenclature to accommodate new concepts and empirical findings. This may seem contrary to the normative use of nomenclature, but it is not. If we created new nomenclature for each new proposal, there would be no way to show connections between the old and the new frameworks. This means that when there is an explosion of nomenclatural proposals for a given topic, there is likely a more fundamental conflict that needs to be resolved. And metaphors set the stage for that resolution.

Theoretical advances rarely emerge from ecclesiastical dialogues among different entrenched viewpoints in which each side expects the other to convert at some point until an eventual winner emerges—what Menachem Fisch calls *inter-faith dialogue*. He argues that what we really need is *inter-faith learning*. Inter-faith learning allows the possibility of cooperation for mutual understanding. We think everyone with a perspective on evolutionary theory today has something to offer, including those who do not wish to part with the old ways. This is why the academic food fight conducted publicly in the pages of *Nature* in 2014 (Laland et al. 2014; Wray et al. 2014) resolved nothing. The disputants on each side tried to convince the other to convert to their nomenclature. They sought no common ground for turning their interdisciplinary dialogue into interdisciplinary learning.

Metaphors allow us to unify different systems of nomenclature. They are the roots of creativity in science, a common metalanguage for people to come together and find common ground to achieve needed change. Metaphors keep us from getting bogged down in trivial disputes. They are not useful for winning an argument.

> Metaphors were never made for keeping score—Jimmy Buffet (1996)

Rather, metaphor is the search engine for interdisciplinary studies.

> If you want to change the world, you have to change the metaphor—Joseph Campbell (interviewed by Bill Moyers 1987)