Creation, Destruction, and the Advent of the Superorganism

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Approximately 14 billion years have transpired since the universe was born. If one scrutinizes what has happened since then for a general principle that can be said to underly all of the disparate events in the history of everything, one could very conceivably settle on the notion that the universe has been growing increasingly complex. First, out of an unspecified state of nothingness, it began to exist. Nothingness is difficult to conceive of, but something is certainly more complex than nothing. Initially too hot and energetic for particles to exist or forces like gravity and the weak nuclear interaction to be separate, the universe expanded, and from its protean singularity emerged an increasingly diverse and intricately structured array of forms and interactions—electromagnetism, atoms, galaxies.

Then, astonishingly, life emerged. The disparate molecules occupying the primordial earth began to aggregate into cohesive entities that behaved in ways their constituent parts were not capable of independently—structural complexity increased profoundly. The mind reels at—and the tongue falters trying to articulate—the seeming infinitude of phenomena that have emerged from life: sex, the territorial aggression of chimpanzees, bigleaf maples, the sensitivity of subterranean mole rats to the earth's magnetic field, whales, and consciousness do nothing to even begin an attempt at enumeration.

Then, one particularly complex structure, the human brain, began to scrutinize the workings of the world and, with ever-increasing accuracy, determine the nature and causes of what it observed. One could say that the universe became aware of itself; for the first time, for instance, it not only consisted of 83% dark matter and 17% normal matter, but also knew this about itself.

The question inevitably arises: has complexity reached its terminal phase? No compelling reason exists whatsoever to believe this is the case. The alternative can thus be embraced: beyond the present horizon, new vistas of unimagined phenomena, emerging from the interactions of their constituent parts, await us. If we were to adopt a morality that truly transcended immediate self-interest, that embraced the notion of responsibility in the most fundamental terms, would we not conclude that we have a duty to protect and facilitate the world's trajectory of growing complexity?

What bearing would such a value have on the present moment, at the beginning of the sixth mass extinction in the history of our planet, when the complexity of civilization threatens the complexity of life? Between 70,000 and 5,000 years ago, synchronous with the spread of *Homo sapiens* over the globe, about half of the world's large terrestrial mammals—creatures such as the giant ground sloth, the dire wolf, the rhinoceros wombat, and the bonnet-headed musk ox, creatures simultaneously strange and familiar, as if we have vague memories of dreams dreamed by distant ancestors in which they appeared—became extinct. Around 13,000 years ago, North America lost more genera than it had in the preceding 1.8 million. In the shorter-term, a minimum of 80 of 5570 mammalian species have gone extinct in the last 500 years, a rate that actually exceeds that of previous mass extinctions. Whether the current crisis for the diversity of life is reckoned from hundreds or thousands of years in the past, we are not yet in the midst of it; rather, we are still standing on its precipice. At the present rate, 75% of all species of mammal will be gone in less than 350 years—or, to phrase it only slightly differently, in 350 years the world will be, in terms of its mammalian occupants, 75% less complex.

In the past, mass extinctions have been caused by things like increased volcanic activity or the collision of our planet with celestial objects. Noteworthy differences exist between humans and celestial objects. For instance, the asteroid that created the Chicxulub crater and ended the epoch of the dinosaurs had no means of asking itself, as it hurtled through space 65 million years ago, what kind of world it wanted to live in—a world, for instance, with or without dinosaurs—nor, had it, if it possessed the means to ask such a question, the capacity to alter its course of action.

The distinction of conscious choice, when assessed in terms of complexity, has far-reaching implications. The exclusive, unequivocal result of past extinction crises has been a reduction in complexity: however one wishes to assess it, there is simply no way that the large, smoldering hole in the ground left by an asteroid even begins to approach the structural intricacy of a single one of the species it eliminates. In the earth's sixth mass extinction, however, something novel is occurring.

We are interacting with our environment in a way that, while denuding the planet of the diversity of its forms, has certain features that bear a conspicuous resemblance to past moments in evolutionary history, moments that resulted in marked increases in complexity. This is because increases in complexity are preceded by, or perhaps simply synonymous with, increases in scale. Increases in scale are synonymous with previously disparate structures becoming cohesive.

The mechanisms underlying it have been entirely heterogeneous, but this simple truth has pervaded the history of life. If one could somehow choose to walk the surface of a pre-life earth—or more pertinently, to swim its oceans—and observe the various molecules that inhabited it, one would perhaps have difficulty imagining how an adequate number of them could ever cohere, each with its particular function, to form a cell. One would see, in short, that the critical condition necessary for the initiation of life, with all of its consequent intricacy, is the formation of structures of a greater scale than any that currently exist. Subsequent stages in the history of life require that the same condition be met. For the development of the single-celled organism to an entity with differentiated organs, numerous cells must remain cohesive, with multiple DNA molecules finding a way to share the fate of a single body.

For the formation and elaboration of an organism to occur, the requisite cohesion of smaller constituent parts is a literal, physical cohesion. However, beyond this scale, beyond the level of integration necessary for the molecules, cells, and tissues of an organism to all function in concert, multiple organisms aggregate to form still-larger systems. On a western slope of Mount Tamalpais overlooking the Pacific Ocean, the snags of a few interior live oaks stand, bleached by sun and time, pocked with countless small cavities, many of which are stuffed with an acorn from an adjacent live tree. The holes have been excavated, and subsequently filled, by the acorn woodpecker (*Melanerpes formicivorus*). These trees are called granary trees and they are the resource upon which the species depends, living in a large group that collectively defends its food store against competitors, with one bird acting as a sentry at all times. This shared resource creates a scenario where each individual birds' interests overlap to a large extent with those of the other members of the group; for instance, they lay eggs in a single nest cavity, sharing the duties of incubation and parenting.

I write this in fall; the ground beneath the granary trees is littered with countless acorns. The birds can be seen flitting through the canopies of the live trees all around their collective home, descending to the ground to retrieve food, returning to their granaries to cache it in vacant holes, and occasionally, beginning work on a new one. No physical force binds the birds together or organizes their collective behavior—they are not covalently bonded to each other like atoms or circumscribed by a membrane like the contents of a cell. Nonetheless, each acorn woodpecker is a complex system, transcending the individual proteins, lipids, and carbohydrates that compose it, and each one in turn is a part of a larger and more complex system, whose emergent nature transcends that of any individual bird.

Such systems may emerge from the interactions of members of different species, with their respective identities becoming so inextricable that they have, essentially, merged. In some cases, they cease being regarded as separate at all. The only time I have ever heard the otherworldly scream of a mountain lion, it was in the pre-dawn hour in the foothills of the Sierra Nevada, and it was from perhaps ten feet away. It is difficult to really characterize what I thought at that moment—I suppose I must have been wondering, at least to some extent, if I was about to die—but what I can confidently assert I was not thinking was “What an unlikely aggregation of two different organisms is making that noise!” I did not think this despite that each of that cat's cells contain DNA both in its own nucleus and in its mitochondria, a relict from a time when prototypical mitochondria and a very ancient ancestor of *Puma concolor*—an ancestor so ancient that you and I are also descended from it—were separate species altogether, before they merged, the mitochondria becoming the energy-producing apparatus of the cougar's cells. Now, it is meaningless to consider them separate entities: neither can any longer exist without the other.

What is crucial to consider about such a synthesis of different species into a single entity is that its constituent parts share a fate. Jellyfish of the genus *Cassiopea* derive sustenance from symbiotic photosynthetic algae that live in their bodies. Should a jellyfish find itself in unfavorable waters or washed ashore, its algae do not have the option of discontinuing this arrangement in favor of a simpler existence—they must either survive or perish with the system into which they have integrated.

Likewise, human action has the capacity to end the existence of species. Should we continue with our massive applications of herbicides and pesticides to the cultivated areas of California's Central Valley, drifting thence on the wind into the High Sierra, then someday the High Sierra may very well lack for the songs of Yosemite toads. In this sense, from a biodiversity perspective, we are like an asteroid. Alternately, however, if we choose to ban or limit the application of chemicals that are imperiling amphibians, the species will persist. If someone writes to the Environmental Protection Agency to urge them do so, or holds a protest outside of one of their offices, or sues them to force compliance with existing environmental law, then something interesting happens: *Bufo canorus* shares a fate with other organisms. If the people who advocate on behalf of them all die, then so too do they. If they are effective—and to be effective, one must live—then the species will also live. The final part of this equation, of course, is the simple truth that humanity's destruction of nature imperils its own existence. For these reasons—because our own existence and that of other species will terminate or persevere depending on how we behave—we are nothing like an asteroid. Rather, we are part of a system, like jellyfish and algae, wherein the parts perish or endure as a result of the behavior of the whole. Because our actions extend everywhere and influence everything, this a system of unprecedented complexity—essentially, a global superorganism consisting of all species.

The moment that human ingenuity gave us the means of destroying nature, the moment we realized we had to make a choice between the preservation and destruction of the earth's living systems, we integrated ourselves into a single body, like the cougar and its mitochondria, made of every living thing on the planet. Its constituent parts are not physically cohesive like atoms or cells, but already, some of us can feel, when Appalachian mountains are denuded of their summits, or when roads are cut into wild forests, wounds being inflicted into our own skin. Whatever we do, we do to ourselves. If we silence Yosemite toads, we tear out our own tongues. If we so greatly warm the Arctic that polar bears can no longer inhabit it, we burn off our own strong limbs. If, however, we choose to protect these and all other parts of ourselves, then life enters a new echelon of integration, complexity, and scale.

We can not escape the reality that we will affect nature through the very act of defending it. We can choose to subject ecosystems to the least amount of anthropogenic influence possible, but it is still a choice, and the fact that we have made the choice, in and of itself, changes the nature of the landscape—we may call it wild, but it is wild in a different sense than it was wild mere tens of thousands of years ago, when manipulating it was not an option available to us. Its wildness will have gained an additional dimension of complexity owing to the fact that it is intentionally preserved in that state.

If, wishing to disavow human arrogance, we reject this truth, we reject evolution's tendency toward greater states of structural elaboration. The facts that nature has an inherent right to exist in a state of maximum complexity and that humans have a degree of behavioral sophistication that is unique among species have, far too often, been regarded as two mutually irreconcilable realities, when in fact they are expressions of the same basic truth. If we make the protection of ecosystems a matter of anachronism or maintaining a static state, we will lose our fight. If we embrace the fact that the world is undergoing dynamic change, and that our efforts at protection are an essential part of that change, then we are relevant and viable.

The duty to defend life is not simply the duty to preserve what already exists. It is also the duty to carry forward evolution's endless trajectory of increasing complexity.