**A Tale of Cells and Cities**

 **Our Human Evolutionary Agenda:**

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 dedicated to the Rockefeller Foundation’s

 **100 Resilient Cities initiative**

***An evolution biologist and futurist, noting the visual similarities of naturally evolved biological cells and cities with long histories, makes an actual comparison of the two as complex adaptive living entities in evolution and concludes that cities have greater evolutionary potential for leading us into a mature and peacefully cooperative future than either nations or transnational corporations. The RC100 initative thus has enormous potential for leading the way.***

**Introduction**

Looking down on Earth’s surface from an airplane, whether by day or night, our cities look remarkably like cells—nucleated cells, with their obvious nuclear ‘downtown’ hubs, scattered smaller concentrations of buildings like cell organelles, flowing transport systems, extensions into the surround like the pseudopods of amoebae.

This has struck me again and again in flying around Earth as an evolution biologist and futurist seeking answers to our big questions on whence we came and where we are headed, all the while teaching my evolving take on them. Eventually I realized that cities were indeed living entities in their own right, and now undergoing a rapid evolution comparable to the origins of the nucleated cells they so resemble.

I became an evolution biologist, seeing myself as a deep ‘pastist’ fascinated by how our evolutionary trajectory could help inform my work as a futurist, working to envision the best possibilities for co-creating a future that works for all. The ancient Greeks had defined science as the study of nature for the purpose of seeking guidance in human affairs and had thus named it *philos sophias*—lover of wisdom, later renamed *sciencia* by the Romans. That suited me perfectly.

In my university training, however, I was only taught a scientific understanding of biological evolution within the framework of the Darwinian concept of competition among individuals in situations of scarcity. That cooperation within and among groups produced abundance, thereby trumping competitive rivalries in scarcity, seemed obvious to me, but that is only now, well over half a century since my post-doctoral fellowship at the American Museum of Natural History in New York, coming seriously into our scientific purvue.[[1]](#footnote-1)

Darwin acknowledged that the theory best fitting the findings of his extensive researches came from his economist friend Malthus.[[2]](#footnote-2) This theory of fierce competition in scarcity was widely adopted and came to inform our very concept of human nature, as well as virtually all our prevailing economic (business and financial) theory and practice.

However obvious cooperation in nature has been to countless people all along, it took the gradual adoption of cellular synthesis and evolutionary group selection, along with the discovery of our wonderfully cooperative gut bacteria—all within science—to publicly acknowledge cooperation as the critical aspect of evolution it always has been.

Cities, unlike nation states whose artificial boundaries have been drawn and then redrawn by conquests or other shifting political decisions, have, unless built all at once by plan, grown naturally from beginnings as small cooperative villages, and their histories have surprising parallels deep in biological evolution.

**The Biology of Cooperation**

The first cells of Earth, called *archea*—ancients—were our most remote biological ancestors. They were the only creatures of Earth for two billion years, fully half of biological evolution. Creating themselves from available molecules,[[3]](#footnote-3) they also invented new ones, and their original WorldWideWeb of DNA information exchange enabled them to trade genes with enthusiasm as they multiplied wildly. Thus they morphed into new configurations and lifestyles as they gradually occupied every niche from the depths of oceans to the benign interface between land and sea, onto the land and even floating to the heights of an atmosphere they co-created through their own excretion of gases. As atmospheric scientist James Lovelock showed us, life created its own conditions for survival and thrival.[[4]](#footnote-4)

These invisibly tiny pioneering ancestors, having divided themselves prolifically for billions of years without break, are with us even now, far more numerous than any of the other life forms they gave rise to, even coating our human guts and skins, living in concert with our much larger cells to protect our inner and outer surfaces from the dangers we bring on ourselves. But let me not get ahead of my story, for there are further developments in my tale of cells and cities between their pioneering of cellular life on a possibly cellular Earth and the human existence we owe them.[[5]](#footnote-5)

My work in evolution biology revealed a repeating maturation cycle in which a unity diversifies into individuals, which then go through a creative, competitive youth, eventually negotiating their differences, and in the best case scenarios forming large new internally cooperative living entities which start the cycle anew on a larger scale. The tipping point from youthful competition to mature cooperation apparently is reached when the energy expenditure of hostilities escalates to life threatening magnitude and gives way to the energy saving survival and thrival brought about by the greater efficiency of cooperation.

The wonders of scientific research permit us to see how the archea play out the first instance of this cycle, beginning when the early Earth’s crust is packaged into bacterial individuals, which then go through their very long creative, youthful phase. In the course of their lengthy youth, they create several global crises: the first a crisis of hunger when they had consumed all the sugars and acids that were their free food, solved by making their own food through the invention of photosynthesis; the second when oxygen, the output of the hugely successful photosynthesizers, proves to be a highly toxic atmospheric pollutant, solved by evolving a new lifestyle in which oxygen can be consumed as an energy source.

How fascinating that our ancestral archea are the only creatures to cause global crises of hunger and pollution until we humans come along billions of years later, and that they solved both crises without benefit of brain! It would seem that our own big brains are an experiment for which the results are not yet in, and so it behooves us to look deeper into this question of maturation, which is leading us to the origin and capabilities of cities.

Back to our story, we find that having solved their global crises, the archea are still in their competitive youth, practicing a form of bacterial colonialism in which the orignal type of archea that make their living as fermenters, which I call ‘bubblers’, are now invaded by the new ‘breathers’, the hi-tech consumers of oxygen that have invented electric motors[[6]](#footnote-6) permitting them literally to drill their way into the bubblers and occupy them, living off their rich molecules, eating them away from within. This proves, however, to be a poor long-range strategy as the entire ‘colony’ of reproducing breathers within the bloated bubblers proves to be unsustainable.

Crises of unsustainability appear to push the archea to new strategies for survival, this time the colonialists taking on board (all this happening in liquid environments) some photosynthesizing ‘bluegreens’ to make food for the beleaguered colony. Lo, the first big leap in evolution since bacteria formed from crustal materials comes about as the archea, having reached energy crises via their exploitative ways, experience the energy efficiency of cooperation.

The most successful of these archaic colonial enterprises become nucleated cells as their now cooperative participants engage in friendly divisions of labor, with the motorized breathers attached to the outside, pushing the host bubblers into areas with enough light for the on-board bluegreens to produce food for the whole colony. All of them streamline by stashing most of their DNA collectively into a central library of information persisting to this day as the amazing nucleus.[[7]](#footnote-7)

Although the fruit of mature cooperation, the nucleated cells are now new living entities in their own right, and so have to begin their own cycle of maturation in the competitive, creative mode natural to evolving biological youth. Just like their bacterial forbears—which continue to flourish as individuals side by side with their cousins inside the huge new nucleated cooperatives—these big new cells now begin to diversify, evolving countless new forms and lifestyles of their own.

After a billion years—half the time it took for *them* to evolve—nucleated cells make the next big leap in evolution by maturing to form their own cooperatives as multi-celled creatures. Thus they bring into play the whole evolutionary story of fungi, plants and animals that spells out the last quarter of Earthlife’s evolution, the part with which we are most familiar, so we can now fast-forward to the dawn of humanity.

**Humanity, Cities and the Age of Empire**

Where, then, are we humans in our own evolutionary trajectory within a world of bacteria, nucleated cells and other multi-celled creatures sharing the same Earth? Perhaps we have seen ourselves a bit simplistically as advanced civilized beings who bootstrapped ourselves from primitive, ignorant and nasty club-wielding cavemen to cultured creators of our hi-tech world of awesome artifacts.

 ‘Original’ or ‘indigenous’ peoples among us remind our hi-tech culture of pre-industrial ways of life. They have survived the predations of humans with the most advanced weapons and most devastating diseases, who claimed more and more of Earth’s surface as their property.[[8]](#footnote-8) We struggle to see them as our equals, even though many of them, through their peoples’ historic experience with hostilities, both internal and external, eventually evolved cooperative values and practices that, upon respectful attention, are often acknowledged as more mature, more respectful of Earth, wiser, more caring and sharing, than the most evident values and practices of our globally dominant, yet now endangered, civilization.

We know from centralized city architecture and artifacts that some ancient peoples built impressive civilizations, to wit the ancient cities of the Aztecs and Incas in the Americas, the ancient cities of China, Asia, the MidEast and Africa. They are known for their spectacular palaces and temples, the most prominent artifacts of empire.

Empire building fits the competitive youthful mode of species in evolution. Whether ruled by actual emperors or by nations or corporations, as they have been in turn, they all fit the model. Thus the now long-standing human habit of empire-building seems to suggest, from a biological evolution perspective, that our civilization as a whole is still in youthful competitive mode.

Empire building is only 6 to 8 thousand years old, however, while complex social life artifacts go back a hundred thousand years and human tools as long as 2.5 million years. The World Atlas lists the oldest continually occupied cities, most in the MidEast, telling how they all began as small villages that “mostly flourished as centers of trade being strategically placed as meeting points of various trade routes.”[[9]](#footnote-9) Byblos, Lebanon, for example, was “consistently inhabited since 5000 BC. The city started out as a fishing village named Gubal. It grew in strides to become a major commercial establishment especially because of its busy port.” In short, it was trade among people meeting at crossroads—the original version of truly free trade—that inspired and grew cities from small villages. The city of Catal Huyuk in Turkey is at least 9,000 years old and tells a story of peaceful cooperation, its artifacts reveal the strong governance roles of women though men and women had equal social status, and excavations have shown a complete lack of walls or weapons.

Thus cities with long histories almost invariably grew as naturally adaptive living entities from small cooperative trade centers. This suggests that humanity completed the evolutionary maturation cycle in countless locations around the world long before empire evolved. If the formation of cities indeed repeats the maturation cycle leading to nucleated cells, and that leading to multi-celled creatures, then we can see why some of the cities beginning as cooperatives went on to begin their own cycle by forming competitive empires.

It is interesting to note another parallel with archaic evolution in the Eurasian nomadic peoples that did not settle down to build cities, but armed themselves against each other for territorial battle and used their weapons to invade peaceful early cities, taking them over[[10]](#footnote-10) much as the hostile breather archea drilled into the sluggish bubblers. In some the invaders merged into city cooperatives; in others they took over to begin competitive empire building. Like the great majority of single nucleated cells, most cities continued to evolve independently as sustainable cooperative entities in their own right.

As empire builders drew boundaries around territories, many cities found themselves included whether or not they had actually been invaded. The Incas of the Andes offered villages and small cities throughout their empire guaranteed livelihoods for all and freedom of worship, providing the state SunGod religion was also practiced. Thus they built a largely peaceful internal empire on what might be called paternalistic socialism, and were able to develop highly scientific agriculture that gave rise to half the food eaten in the world today according to the World Bank.[[11]](#footnote-11) In other cases of empire building considerable coercion was involved.

The human practice of drawing and redrawing artificial boundaries has persisted for thousands of years, throughout the first two waves of empire building and has roots in the territoriality of many natural creatures including fishes, birds and mammals, albeit *their* skirmishes are almost entirely ritual and bloodless. National empires, however, were based on the uniquely human conquest of disconnected foreign acquisitions with a ruling ‘homeland’. Nation states, born of empire, were created along arbitrary boundaries that have little or no relationship to natural ecosystems except where they are coast or rivers, often cutting up previously settled human communities and creating new conflicts thereby.

In the development of corporate empires, the break from a natural evolutionary process becomes more obvious. Their ‘turf’ is even more scattered and shifts with their profits and losses, while their governance and financial transactions are increasingly virtual. Finance, run by increasingly complex and highly intervoven businesses, is mostly virtual now, its inner workings invisible to most people in the physical economy. MBA programs for the mostpart leave it out of business training altogether, settling for teaching within-business accounting.

Nevertheless, transnational corporations (TNCs) exert strong influences over national governments, not to mention institutions of higher learning. While their interest is limited to their resources, labor and markets, and so primarily in the laws that constrain or liberate them and the finances that tax or subsidize them, these interests lead to investing considerably in politicians friendly to their interests, as well as to putting their own people into government positions. As of 2014, ranking the biggest economies in the world by the GDPs of nations and revenues of TNCs, 37 of the 100 largest economies in the world were corporate rather than national.[[12]](#footnote-12)

For a while, it had looked as if nations would come together in friendly cooperation at a global scale. That was the stated intention in creating the United Nations, for example, with its mission of world peace. But as nations give way to TNCs through trade agreements that explicitly undercut national sovereignty and environmental policies, the wealth gap between rich and poor continues grows to unmanageable proportions, while our ecosystems continue to be degraded with species disappearing at the rate of past great extinctions. Now, evident climate change brought on by burning fossil fuels threatens to throw the entire Earth into a Hot Age that will last for millennia.

Unfortunately, continued warfare and fear thereof keeps fossil fuels burning as military expenditures create some of the greatest financial successes of corporate empire. We have not acted on the fact that it is cheaper to feed your enemies than to destroy them, because TNCs, by their charters, must look to lucrative projects such as war, in addition to cheap resources and labor, to maximize profits.

**The Evolutionary Mandate for Cities**:

In this scenario it is increasingly clear that naturally evolved and internally cooperative cities are our best hope for bringing humanity into its mature, peaceful and sustainable future.[[13]](#footnote-13) Cities were the fruit of our first wave of cooperation as humans and have the clear potential for completing their own maturation cycle now. Just as their nucleated cell forbears matured to form multi-cellular creatures, cities can home their internal cooperation and come together with each other in a distributed global multi-citied network that shares their best practices and divides global tasks appropriately.

In 1800 only 3% of the human population lived in cities; their exponential rate of growth shows well over half of us are now in urban areas, and predictions for 2050 have 70% of us living in cities worldwide—a percentage that holds already, and is even higher, in some developed countries. The overall trend is clear[[14]](#footnote-14) and if nation states fail under the burden of our perfect storm of crises, cities will have to play ever more important roles in all aspects of human civilization.

The internal problems cities face now are the same glaring ones facing their nations and their world—joblessness, homelessness, health crises, unequal educational and other opportunities, racial tensions, environmental degradation, energy grid failures, traffic congestion, political corruption and so on. Thirteen of our twenty largest cities globally, as well as far more smaller ones, are coastal. Their sealevel airports, piers and sewage systems, as well as other infrastructure and populations, are directly threatened by climate change, as is already evident.

Our hope lies in the resilence of humanity itself—in the vast array of opportunities for engaging the citizenry of cities in peaceful means of solving their problems and developing resilience in the face of oncoming disasters.[[15]](#footnote-15) Inspiring and building internal cooperation through truly democratic citizen engagement, each city can solve problems and become a healthy partner and role model for other cities.

The Rockefeller Foundation has recognized and is supporting this process of solutions and resilence in its 100 Resilient Cities project (RC100).[[16]](#footnote-16) Its stated mission is: *Helping cities around the world become more resilient to the physical, social, and economic challenges that are a growing part of the 21st century*. My city, Honolulu, was appointed in the 3rd cohort of RC100, and we are fortunate that cities such as Oakland, California, two years ahead of us in the first cohort,[[17]](#footnote-17) can help us design our own mission as we clearly share many of the same problems from homelessness to rising seas.

Oakland, in its two-year report, says:

“A key action of the Resilient Oakland playbook is to devleop principles for community engagement in Oakland...The ‘secret sauce’ of Oakland is rooted in our people and the 75 neighborhoods they shape...Diversity is a source of economic vitality for many Oakland businesses. Small businesses represent the foundation of Oakland’s local economy, with 90 percent of businesses in Oakland employing less than 20 people. These businesses face challenges, such as rising commercial rents, increasing gentrification, and recent overall economic stagnation. Given that many of the City’s small businesses are also located in low-income, minority-based neighborhoods, protecting the viability of these businesses is also a matter of equity and social justice.”

To restate my case, cities are the most promising human-created living entities able not only to solve their internal problems, but to lead the way in evolving humanity to its second and this time global wave of maturity. Oakland’s report demonstrates the language of mature cooperative problem solving and Oakland is clearly drawing on its creative diversity as it works hard to rehabilitate its neighborhoods, support local economy and improve its self-governance.

*That* is exactly what is now demanded of us all as we must navigate this perfect storm of crises we humans have created. Increasingly severe natural disasters due to climate change, the growing refugee crisis due to both climate change and the persisting horrors of competitive warfare, the many problems resulting from an extreme wealth gap, are all inescapable now. We are caught in these stormy waters, like it or not, and have no choice but to navigate our way through them.

Living in Hawaii, I have become acutely aware of its marvelous ancient tradition of Wayfinding—of sailing oceans without compass by knowing the ways of Nature so well, so intimately, that one simply does not get lost. Wayfinding is exemplified by Honolulu’s global ambassador, the traditional double-hulled canoe *Hokule’a*, in its *Malama Aina* (Care of the Earth) circumnavigation of Earth, stopping at one coastal city after another on all continents to spread its deep Polynesian values of caring for each other as we care for and share our beloved Earth.[[18]](#footnote-18)

Only mature evolutionary mode, scientifically and spiritually inspired, physically expressed, will work toward a better future now. Hostilites must give way to harmonies and cities as natural living economic polities can lead the way. City by city we can learn and teach each other as role models in evolving beyond old top-down models of our youthful competitive mode that disempowered too many people by holding them down or leaving them out. Truly cooperative citizen participation *can* solve chronic problems creatively and build inclusive cooperative economies that are resilient in growing climate crises.

The greater purpose of building self-sufficiency and cooperation within cities is to prepare them for voluntary union with each other—the globally distributed networking alliance that replaces the old idea of centralized global governance. As multicelled creatures our bodies are an alliance of equally important organs in collaboration and mutual support. The brain is not a dictatorship or any other kind of centralized government; it is largely an information clearing house that passes on its knowledge 24/7 to all other organs, which in turn feed back their information. The RC100 project is a vital step in such information sharing as its cities work on their solutions.

Next time you look down on cities from high enough to see them in their entirety, see them in your mind as living cells on a cooperative human scale and send them love! When you come down, engage within your own city, or one near you, follow the RC100 cities for inspiration, and thus become a Wayfinder through crises. Just make sure you find a way to do that which makes your heart sing with passionate joy in the ecstacy of co-creating vibrant community and weaving that into a truly mature human family at last!

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About the author:

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 She has appeared in numerous films and is author of ***EarthDance: Living Systems in Evolution, A Walk Through Time: from Stardust to Us, Biology Revisioned***(with Willis Harman) and new ebook ***Gaia’s Dance***. Website: <http://sahtouris.com>

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1. See for example David Sloan Wilson’s *Does Altruism Exist?* Yale University Press 2015. [↑](#footnote-ref-1)
2. Thomas Malthus, head of Hailybury College, founded by the first multinational corporation, the East India Company, became famous for his conclusion, after surveying the world, that humans always outstrip their food supplies. Charles Darwin wrote about his own theory in his *Origin of Species*: “*This is the doctrine of Malthus applied to every aspect of nature*.” This agreement between the ecomomist and the biologist rationalized colonial exploitation and [↑](#footnote-ref-2)
3. This language is in keeping the the definition of life as *autopoiesis*,the self-creation of living entities, given to biology by Francisco Varela and Humberto Maturana, first publishing it in *Autopoiesis and Cognition:the Realization of the Living* (1st edition 1973, 2nd 1980): [↑](#footnote-ref-3)
4. This is the Gaia Hypothesis of James Lovelock (with Lynn Margulis), that life creates its own conditions for flourishing, as expounded in *Gaia: A New Look at Life on Earth*, Oxford Univesity Press, 1979 as well as a plethora of subsequent books on this subject, including my own. [↑](#footnote-ref-4)
5. Lewis Thomas, author of *Lives of a Cell*, saw Earth itself as a huge living cell and quippeed that ancient bacteria may have invented us as giant taxis to get around in safely, a friendly thought that looks ever more plausible as we discover more about them. [↑](#footnote-ref-5)
6. Nanotechnologists are fascinated by these bacterial motors, made of over 40 kinds of proteins, configured as rotors, stators, cam shafts, ball bearings, etc, in an amazing parallel with motors we humans build, though far more efficient! [↑](#footnote-ref-6)
7. My story of bacterial evolution is based on Lynn Margulis’ brilliant work on the evolution of nucleated cells. She thoroughly approved my way of telling what is really her story, as told in her popular book *Early Life*, Science Books International, 1982 as well as more academic texts. [↑](#footnote-ref-7)
8. See Jared Diamond’s *Guns, Germs and Steel*, Norton 1999. [↑](#footnote-ref-8)
9. http://www.worldatlas.com/articles/oldest-cities-in-the-world-still-in-use.html [↑](#footnote-ref-9)
10. As described by Riane Eisler in *The Chalice and the Blade*, Harper 1987, based on the earlier work of archeologist Marija Gimbutas at UCLA. [↑](#footnote-ref-10)
11. Heard in a lecture given at the World Bank headquarters in Washington DC in the early 1990’s. [↑](#footnote-ref-11)
12. https://makewealthhistory.org/2014/02/03/the-corporations-bigger-than-nations/ [↑](#footnote-ref-12)
13. New cities that are designed, built and occupied as wholes, as in the MidEast and China, are not living entities like those naturally evolved. Whether their living occupants can turn them into living entities as cities remains to be seen. [↑](#footnote-ref-13)
14. http://www.nytimes.com/2014/07/11/world/more-than-half-the-global-population-growth-is-urban-united-nations-report-finds.html [↑](#footnote-ref-14)
15. Marilyn Hamilton’s *Integral City,*  New Society, 2008, is a great handbook of solutions. See also the website at http://integralcity.com for lots of available supporting materials and consulting. [↑](#footnote-ref-15)
16. http://www.100resilientcities.org/ [↑](#footnote-ref-16)
17. http://www.100resilientcities.org/strategies/city/oakland#/-\_Yz47OTk0OCdpPTEocz5j/ [↑](#footnote-ref-17)
18. http://www.hokulea.com/worldwide-voyage/ [↑](#footnote-ref-18)