
PERSPECTIVE

Scientists' Warning on the Problem with Overpopulation and Living Systems

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Abstract

A biological system can be defined as a collection of interacting elements, organised together with a common function(s). This framework can provide valuable insights into the problematic interactions between humanity and the rest of life on earth. Life is composed of a nested hierarchy of systems, united into a vastly complex, global system of ecosystems, the biosystem. The function of the biosystem and its components is the sustainable reproduction and evolution of life. Humans have many of their own systems, including a global, commercially oriented system of corporations and social structures, which we term the corposystem. A major aim of the corposystem is endless growth for profit, which depends on endless human population growth: not sustainable on a finite planet. These two global systems are clearly in direct conflict. To preserve the biosystem, including humanity, we must align the corposystem ethic with the reality of the biosystem's needs.

Keywords: biosystem, corposystem, evolution, information, overpopulation

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Introduction

Our 'blue-green marble' – our living earth, blue waters and green plants that support the lives of animals, including us – is turning brown. Areas of brown earth, as seen from space, spread across the continents: places where lush vegetation can no longer flourish. The substance of life, the biomass, is draining out of life and into the cities (West, 2018), which cannot recycle it into living matter. Planet Earth is being depleted of life, with mass species extinctions (Kolbert, 2014), as well as climate change and degradation of soil and other ecosystems. David Suzuki, David Attenborough, William Ripple and many more biologists, with astronauts, agriculturists, medics, foresters and more, have seen that planetary life is crashing, and they have warned us (Ripple et al., 2022).

The concern is valid, the danger clear and present. But much of public opinion has minimised these warnings because: (1) we have an outdated, misleading view of evolution; (2) we believe that we can use technologies to save us as we have done with great success since *Homo sapiens* invented agriculture or used fire; (3) many people do not realise or believe that the current global crises are largely caused by human overpopulation (Bajaj and Stade 2023; Rees, 2023); (4) we believe the consequences will not be all that bad and we can adapt to any environmental changes; and (5) many people reliant on social media have learned to expect simple answers to our complex problems (Bajaj and Stade, 2023; Crist et al., 2022; Salmony, 2023; Wolf et al., 2021; Rees, 2023).

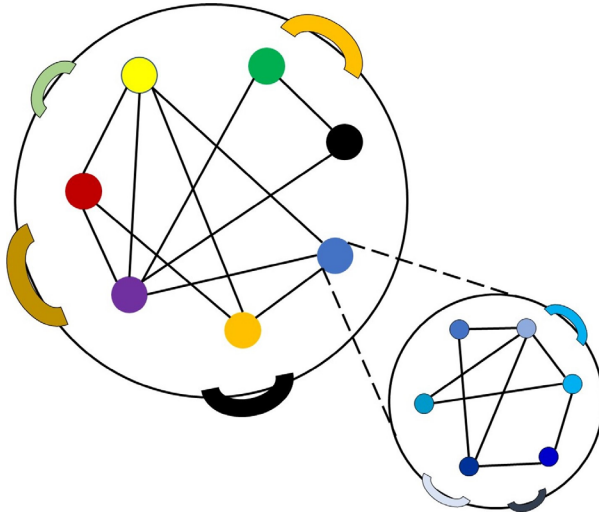
This article aims to summarise a more current view of evolution, of life relative to its environments, and of human relationships with them (Lamoreux, 2021), which may help to understand why the above five views are mistaken and how we may more appropriately address our current planetary crises. We propose that urgent and radical changes are needed in human behaviour and in our dominant social system, to move away from the unsustainable goals of profit and endless growth, and align ourselves with the overall needs of life on earth.

Biosystem and corposystem

Here we introduce key concepts: the biosystem (and how a living system can be sustainable), and the corposystem. A biological **system** can be defined as a collection of elements that interact together with a common, evolved function (Meadows, 2008) in support of life (Figure 1), although the idea of

function needs qualification at the ecosystem level and above (more below). The components of a system can themselves be systems, and so on, as happens widely in biology (Figure 1).

Figure 1. System and subsystems



The outer circles represent systems, which could be living systems. The coloured circles represent components of each system, with one expanded to show that the components are subsystems – e.g. species within an ecosystem, organ systems within an animal or organelles within a cell. The solid lines represent interactions / communication between the components (such as between flowering plant and pollinator). The arcs on the outside represent emergent properties (such as shape and colour, see text later). The interactions between components will involve emergent properties.

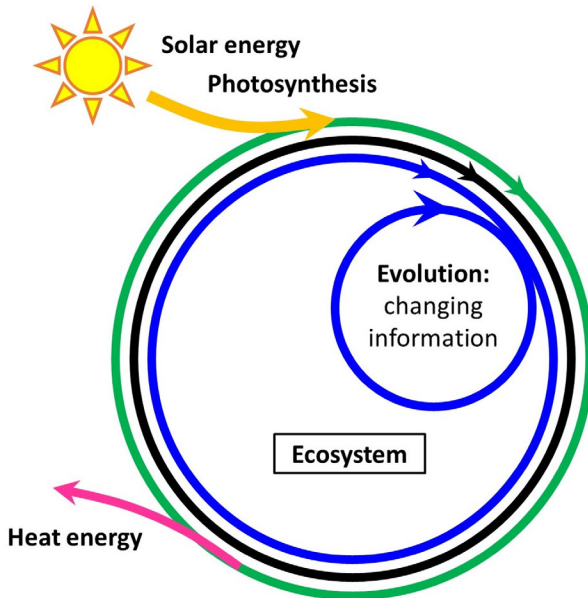
Living cells are systems composed of organelles and molecules. Organs and organ systems are composed of cells and tissues. Likewise, individual living organisms are composed of organs, species are composed of individuals and ecosystems of species. The solid lines represent the highly evolved and balanced interactions/communications among the components, whether components of a living cell or of an entire ecosystem. These living systems are also **complex adaptive systems**. Complex means that their subsystems are disparate (not all the

same), and adaptive means they can respond to their environments (Meadows, 2008). An ecosystem that is not in evolutionary steady state, for example where an invasive species has been introduced, may also become a 'complex maladaptive system', where its subsystems are in conflict (Wilson et al., 2023). Such systems will generally be unstable. The entire planetary biosphere is composed of countless interacting and overlapping ecosystems that have evolved naturally over billions of years, from simple toward complex (although not monotonically but occasionally via catastrophes and mass extinctions), to work efficiently and sustainably together; so we call it here the **biosystem**. Ecosystems and the global biosystem can be said to have a function, since natural selection operates on them and continues to select the current version. In this sense, their function is the sustenance of life. The biosystem plays an active role in the biogeochemical (combined biological, geological, and chemical) cycles of Earth (Turner, 2018).

At each level of organisation, we find **emergent** properties – properties of an entity that are not found in its component parts (Figure 1). The emergent properties of a living system are responsible for that system's particular functions, including communication with specific other systems. Examples of emergent properties at the planetary level are the global distribution of species and their migrations, and the atmospheric levels of oxygen and carbon dioxide. At a less complex level, an emergent property of an enzyme in a cell might be a specific form of catalysis.

A defining characteristic of the biosystem is its ability to sustain itself using recycling processes, while responding to changing environments using evolution (Figure 2).

Figure 2. Requirements of a sustainable living system.



Yellow/incoming arrow: Energy from the sun is captured, through photosynthesis. *Green/outermost cycle:* Organic chemical energy cycles through life (food chains). *Black/next cycle in:* Organic matter recycles, carrying biological information and energy within biological structures. *Blue/two innermost cycles:* Genetic (and other biological) information, determining the processes fuelled by the energy, recycles over long timescales, modulated by evolution. *Pink/arrow leaving:* Energy released as heat, after doing work maintaining life.

Figure 2 represents minimal requirements of a sustainable living system (an ecosystem or the biosystem). Importantly, all these functions are carried out by the organic molecules of living cells, each function exquisitely tailored to the requirements of ecosystem members.

1. To capture energy from the sun (yellow/incoming arrow in Figure 2), convert it to organic chemical energy, and convey this appropriately to every living process that requires energy (green/outer cycle);

2. To recycle and propagate the information that directs life processes, including genetic information, with modifications over time in response to its environmental system (evolution) (blue/inner two cycles), and
3. To recycle the materials of which it is composed (black/intermediate cycle). Living systems recycle, making no pollution.

Because the energy input is from the sun, a sustainable living system must include organisms that can capture light energy and convert it to the organic energy of life systems: plants and some micro-organisms. For sustainability, ecosystems and the biosystem maintain and require an intricate balance among their component systems and subsystems. Importantly, animals such as humans are not sustainable on their own, but require a complete ecosystem providing food and recycling waste.

Homo sapiens is a global species, participating in many ecosystems. We have diverse interactions with other life, which are vital to our survival. The biosystem generates the many food chains that feed us, using solar energy, and is crucial in recycling much of our vast output of waste.

We humans also organise ourselves into various types of interacting human systems, though still within the biosystem – such as families, villages, colleges, orchestras, nations, social systems, corporations and so on. One global, market-oriented social and economic system, however, has come to dominate the behaviour and beliefs of many populations on the planet. This we term the **corposystem** (Lamoreux, 2021). For many humans it has replaced the biosystem as their primary experienced environment. We defined a system as having a function(s), so can the corposystem be said to have a function? Arguably, as an emergent social system, it has evolved and been selected for relative success, like living organisms and ecosystems. In this case its ‘function’ may be seen as what has made it survive (so far) and develop as it has: growth for profit, through competition and domination. Thus, perpetual growth is intrinsic to the corposystem and many of its subsystems and it has become, over time, better and better at promoting growth as well as normalising the idea that growth is necessary. This produces the dilemma *Homo sapiens* faces today. **The growth of the corposystem is now in conflict with the balance of the biosystem.** The goal of endless growth is causing massive changes

and loss of balanced interactions among the systems of life, beyond the capacity of the biosystem to adapt or evolve.

What is evolution?

Evolution of a living system, as currently defined, is a change over time in its genome (meaning all the heritable information in a particular system: biosystem, ecosystem, species, individual or cell). Evolution is not primarily, as many imagine, 'survival of the fittest', if fittest means strongest or most dominant (Feldman, 2022). Unfortunately, this 'red in tooth and claw' image of evolution is misleading (Ripple and Beschta, 2012; Ratajczak et al., 2022; Bishopp et al., 2010), and has contributed to a widespread and influential view of ourselves, humans, which 'portrays our basic nature as selfish, with competition as our fundamental drive' (Jinpa, 2015). The concept has probably played a significant part in establishing the corposystem attitude that self-centred competition is natural and good.

Science, however, does not see evolution as survival of the strongest individual specimens. When current physics and systems thinking (Felder, 2022; Goldsmith, 1981; Lloyd, 2008; Margulis, 1998; Page, 2009; Schumacher, 2015; Strogatz, 2008) are factored in, evolution of living systems can be described much more accurately as a collaborative balancing act (Lamoreux, 2021). As Dawkins (1982) has noted, we can speak equally correctly of natural selection acting on genes, on individuals or on interacting groups; but it is crucial to note that the first two never happen without the third. This kind of interactive evolution is called **coevolution** (Medina et al., 2022). As Bateson (1972) also pointed out, the principal unit of natural selection is a **relationship** between an individual system and the environment within which it evolved, represented as lines in Figure 1, such as flowering plants and their pollinators which coevolve to fit each other, in addition to more complex networks. Darwin's finches evolved different beaks and behaviours on different islands in relation to their different environments. By fitness, Darwin meant suitability, not strength or dominance. Like a developing embryo, and in the absence of major disruptive processes, the biosystem can propagate and evolve for very long periods, sustainably and resiliently, because of the precision of the cross-talk among the component systems and their components, honed by long evolution. As we will argue, this resilience is under major threat from humans.

It is commonly imagined that evolution always leads to improvements, or that evolution is primarily about numbers of offspring, but that is not so. True, if there are insufficient 'replicators' then a system (species or other inherited system) will not survive (Dawkins, 1982). However, a system that overpopulates or is otherwise destructive to its environmental system is also unlikely to survive, and the environmental system also may not. Or systems may become incompatible with their environments. Compatibility with the local environmental system is the measure of evolutionary survival.

When a living system becomes extinct, all of its genetic information is lost, including communication links that bind its components together, such as species into interacting sets or ecosystems, and ecosystems into the global biosystem. This information loss is also evolution and, unlike adaptation, it is permanent. The current mass extinction threatens dangerous reductions in genetic diversity in many ecosystems and loss of essential elements of the biosystem as a whole: essential in the longer term to preserve many forms of life including humans from our planetary impacts.

Evolution in terms of systems and information

We characterised life above as a system of systems of systems (etc). We introduced emergent properties (Figure 1) – those properties of any entity that are not properties of its component parts. For example, zebras are striped, but their component organs, even hairs, are not striped. It is interesting to notice that the shared emergent properties of a given type of living system (species, organ, etc) include its **phenotypes**: the name in genetics for genetically encoded physical traits. Communication between and within systems involves these phenotypes/emergent properties. For example, colour patterns can be used within an ecosystem for male-female recognition, or camouflage against predators, or attraction of a pollinator. Within our own bodies, chemical and electrochemical phenotypes are used by the organs to sustain their proper interactive balance. Communication can be defined as receiving and/or sending any kind of information. Colours, touch, chemical changes, sounds, the genetic code: these are all relevant information (Ben-Naim, 2022; Schumacher, 2015; Meadows, 2008).

Since life began, evolution has generated progressive increases in complexity, information content and levels of organisation of living systems, as well as increasing

diversity. Indeed, this concept can be traced back through the physical evolution of the universe, where, since the Big Bang, there were progressive increases in local complexity and information content of structures, through subatomic particles, then atoms, molecules, gas, stars, solar systems and galaxies (Lamoreux, 2021 and recently analysed by Wong et al., 2023). With life, there is additionally the process of natural selection of genetically transmitted traits. Here evolution has often involved recombination of simpler systems (Margulis, 1998). Cells evolved with organelles, some of which came from primitive bacterium-like cells. Simple multicellular organisms arose by combining cells. Then there were evolving interactions between species (e.g. prey-predator), self-sustaining multi-species ecosystems and eventually our overall planetary biosystem, which continues to evolve.

In this way, evolution has generated a progressive increase in genetic information content and biological complexity. The genes encode interactive behaviour as well as structure and metabolism. We cannot directly measure all the information in an organism in bits or bytes (except the genetic code, but that is only part of it). Information is also constantly flowing between living system components at each level; for example between organs in a body (neural impulses, hormones etc) and among interacting species in an ecosystem.

For sustainability, ecosystems and the biosystem maintain and require an intricate balance among each other and their component systems and subsystems. Species must be able to interact well within their ecosystems, or they will not survive, because evolution (coevolution) selects systems of which the interacting components function best together (such as a flower-pollinator pair). Lloyd (2008) proposed that the complexity of the biosystem is so great that it would take a quantum computer as long to describe it as life itself takes to live it.

Indeed, the biosystem and its components are vastly more complex and precise than we can understand in detail, an important point that has contributed to our species' falling out of balance with the biosystem. Anyone expecting simple answers to this crisis will be disappointed.

Evolution, adaptation and climate change

Adaptation by living systems is their genetically programmed ability to sense and respond to their environments. In winter, deer migrate down mountains and trees

shed leaves, then both return in the spring. Each species communicates with its environment in crucial ways, as discussed above. Many people believe that we and the biosystem can adapt in this way to climate change. They may therefore not be very concerned about environmental issues because, if it could so adapt, then our biosystem could one day return to its former fruitful cornucopia of 'environmental services' within which humans evolved. However, the recent human-associated changes, including rapid climate change and many kinds of overgrazing (abetted by corporate agriculture), are too dangerous to be ignored, because a large part of the change is evolution rather than adaptation.

We have increasingly been changing or destroying environments to which living systems are adapted, and either replacing them with our technologies and monocultures or reorganising them using foreign species. Species are out-competed through human hijacking of their food sources and habitats, to supply our billions of humans with food, habitation and transport. Other species are thus becoming extinct at a high rate (Kolbert, 2014). Such changes break the inborn links, the intricate web of naturally evolved communication among species and organisms, the result of billions of years of evolution. This leads not to adaptation but to the irreversible changes of evolution, including disruption of the balance and communications among the species that is required for the sustainability of the entire biosystem. With species loss, heritable information is lost forever.

Technology, biosystem and balance

The only proposed reaction among far too many corposystem leaders (company boards, national politicians) to our biological crisis is to ignore overpopulation, grow more, and attempt to rebalance the resulting biological imbalance using human technologies. This is inadvisable for two reasons at least: it further unbalances the biosystem, and human technologies cannot be specifically designed to efficiently address the needs of biological interactions. Life is more efficient than our technologies can be (West, 2018).

Homo sapiens has not until recently considered making major efforts to retain the ecological balance of our environment; instead, many of us are proud of the global changes that we have made in the fabric of life. Historically, humans have responded to ecosystem feedback loops and limiting factors by using technologies to eliminate them. An example is our invention of farming, producing more food

and supporting many more people (Hopfenberg and Pimentel, 2001). Another is our medical technologies that counteract infection and disease. Probably the biggest boost in our populations came with the industrial revolution, based on ancient sources of organic chemical energy, fossil fuels, which are now generating massive pollution and global heating and need to be discontinued as soon as possible.

As a result, our population has exploded. To imagine that this would not affect our relationships with the biosystem is so unrealistic that it qualifies as denial (Turner, 2018). We need to acknowledge that humanity is experiencing a classical out-of-control overpopulation event, as global population is already well beyond what is considered a sustainable level and still growing even so (Tucker, 2019; Rees, 2023). Such overpopulation events result in population crashes when a species reaches an inescapable limiting factor, such as a completely exhausted food or water supply. The population typically then crashes to well below the previous sustainable level, after which it may or may not survive.

Up to now we have used technologies, as in the Green Revolution, to extend or eliminate limiting factors. However, because of the complex interdependence of the biosystem and living systems in general, we can no longer continue this practice. The efficiency of our technologies cannot match the overall efficiency of living systems, perfected over billions of years (West, 2018). The solution to our overpopulation must not be to try further to change the biosystem, which supports our life, nor to increase energy generation, whatever the sources, as that would risk resulting in yet more people (Hopfenberg and Pimental, 2001). Further increasing efficiency of human food production is also no longer a solution; this would cause even more competition with other life forms, accelerating species extinction and irreversible loss of genetic information. If we want to sustain *Homo sapiens* within the biosystem, we must now use our brains and technologies, particularly birth control technologies, to restore or replace the checks and balances that we have overwritten with previous technologies. Otherwise, nature will 'control' us, and the suffering will be enormous.

The corposystem problem

The goal of the corposystem is not to save human life, but to make as much profit as possible, through growth, as mandated by typical corporate charters. Economic growth (say of a nation) means more total production and more

total consumption over time, which requires population growth. With a stable population, economic growth would require the average individual to continue consuming and producing more each year forever, which is of course impossible. Accordingly, the corposystem needs, and often actively promotes, human population growth, requiring ever more resource provision from the biosystem. On the contrary, for sustainability (Figure 2), the biosystem requires balance among its component systems, rather than nearly all its global resources going to a single species, humans. Moreover, with a stable or falling population, total consumption and production can stabilise or fall with no loss of living standards.

We will need radically altered economic goals if we are to rescue life on earth, including humanity. Unfortunately for its own survival, the corposystem works hard to oppose this concept of overpopulation, even to the point of demonising the word. It supports only those so-called 'solutions' that allow its continued growth, and actively denies that overpopulation threatens the balance of the biosystem. It is a growth machine, and will not voluntarily stop.

The corposystem, through extreme human expansion, has already markedly unbalanced the biosystem, with major changes and mass extinctions. After four or five billion years of success, the biosystem seems unlikely to collapse altogether. The corposystem, however, requires endless growth, which is impossible, and thus it is highly vulnerable to collapse. Various activist organisations aim to make the corposystem less harmful, which is admirable, but it is crucial that they also work to support the biosystem.

Addressing symptoms of overpopulation

Before this century we were using 'spare' biosystem resources that, like body fat, could be regenerated, as long as we did not exceed carrying capacity. But as of 2000 (data from the World Wildlife Fund), humans have been consuming more resources than can be regenerated by the biosystem. As a starving animal metabolises its own body, we are now consuming the muscle and organs of the biosystem.

To ecologists and many others, human overpopulation is clearly the underlying cause of our many resulting crises, including climate change, famine, territorial wars, pollution and so on. Yet many of those in power, and even some activists

and scientists, still deny the role of overpopulation, and focus on treating only these symptoms, if anything. The symptoms will of course continue to worsen unless we also acknowledge and eliminate their common underlying cause.

We should not relax and imagine that nature will take care of the problem. Nature will of course; it already is. The next limiting factors are here and expanding: famine, war, pollution, plague and social and economic disintegration. We are of course advocating only the humane approach to overpopulation, active reduction of birth-rates. This can be politically very challenging and can reduce population only over long time-scales, so that active reduction of consumption per capita especially in rich, highly-consuming nations is also crucial to support the biosystem (Steffen et al., 2015; Samways, 2022). Both types of action are urgent, including reduction of food waste where possible and dietary changes away from land-, water- and carbon-intensive items.

Some faith communities are being told that all is well because God will save us. But if God is the Creator, would this not be asking Him to save us from His own laws that govern the Creation? This seems inconsistent. As Lyla June Johnston (2022) says, 'When you break a system that the creator has made, you break a system that was designed to support your life.' This understanding is indeed basic to our major wisdom traditions and religions (Antal, 2018; Jinpa, 2015; Johnston, 2022; Loy, 2010, 2019; His Holiness Pope Francis, 2015; Rasmussen, 1998; Salmony, 2023). Basic science is of course much younger than the wisdom traditions, but has been forced to recognise the same limitations (Bishopp et al., 2010; Goldsmith, 1981; Ripple and Beschta, 2012; Ripple, 2022; Ratajczak et al., 2022). We humans are not the centre of the universe, or of life. There are more powerful realities that we must consider as we try to save our responsible place within the biosystem. Ignoring the reality will not change that reality, nor will it solve our problems.

The more people there are, beyond sustainable numbers, the more suffering results. While it is rewarding to help suffering people, it is heinous to increase their numbers knowingly. The danger from treating only the symptoms of our overpopulation is that, in future, the suffering people will be everyone.

We can no longer fix our problems with technologies, for reasons explained above, especially when in reality they are used to deplete the biosystem further to make

money for the corposystem and/or to support ever more humans. This will intensify the problems, by further disturbing the exquisite balance that the biosystem requires for its own wellbeing (Lamoreux, 2021). Instead, the long-term cure for *Homo sapiens* is to change our corposystem-based behaviours and attitudes (Johnston, 2022, for example), towards managing our birth-rates and consumption worldwide, as recommended by Tucker (2022) and Earth4All (Callegari and Stoknes, 2023) among others. Only thus can we return our species to a size and to behaviours that are compatible with the welfare of the planetary biosystem.

According to Tucker (2022),

There is a large community of thoughtful practitioners who have spent decades building data-driven foundations for their programmes' effectiveness who would simply argue, 'Give us the budget to do it, and we will achieve the goal – ethically.'

In conclusion, if we want our children to survive, we must demand that our governments, media and the United Nations explain, promote and fund the urgent need to reduce our populations.

Acknowledgements

Many thanks to Russelyn Connor and Shodo Spring for important critical reading of the manuscript, to David Samways for valuable editorial comments and to Bare Bones Biology.org for backup and support.

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