

## **The Challenge of Reconciling Biological and Cultural Imperatives in the Quest for Peace and Sustainability**

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The science of biology is distinguished from geology or astronomy by the operation of natural selection and evolution. Rocks endure, wear and erode but do not evolve. Life forms reproduce and adapt to the various selective pressures imposed on them by using the capacity to pass on a modified genetic inheritance. Modern humans have developed a cocoon of protective technology and practices that operates to defeat this tyranny of natural selection. The challenge for us now is to evolve culturally rather than biologically.

We no longer conform to many of the limitations imposed by the natural environment. There is no way, for example, that the mega-cities of the cold, northern countries could exist without massive energy consumption for heating and the ready, rapid supply of fresh food from more temperate climates. Large numbers of us are living longer than at any time in history. The impact of human needs on the quality and availability of the land, water and atmosphere that sustains all life seems to have an inexorable, negative trajectory. Manipulating the world for our advantage has created extraordinary selective forces that both impact on other life forms and are beginning to backfire on us.

Biological adaptation and natural selection requires time. Though this may be less of a problem for rapidly replicating organisms like bacteria, the magnitude of the effects can be such that longer-lived species simply succumb and disappear. The industrial revolution, which led to the widespread "harvesting" of coal, oil and other non-renewable resources is less than 250 years old. The pace of biological extinction over the past century or so can leave us in no doubt concerning the malevolent face of the interaction between human culture and the biosphere that surrounds us.

The evidence of global warming suggests that ignoring basic realities has the potential to compromise our long-term well-being as a species. War follows when tribes and nations compete for dwindling resources of arable land, water and food. If we want future generations to enjoy peace and prosperity, a good part of our creativity and commitment must now be focused on achieving a harmonious and sustainable world. How do we replace mind-sets and economic models that emphasize short-term advantage with deeply held convictions and strategies that place equal value on present and future needs?

The terms "peace" and "sustainability" address aspects of the human condition and behaviour patterns. My pocket Oxford dictionary defines "Peace" as: "quiet, tranquillity; mental calm, serenity; freedom from or the cessation of war". Tranquillity and mental calm imply a capacity for introspection and an inner life, which most consider as essentially human traits. Perhaps the higher primates, like the chimpanzees that share about 98% of their genomes with us, may also have some of these characteristics. War, in the sense of sustained, planned aggression and mass killing is unique to our species.

When most people think about inner peace they mean tranquillity and mental calm. It would hardly be appropriate for me to attempt a discussion of psychological harmony in a nation where Buddhism is the predominant belief system. However, promoting “inner peace” in the sense of maintaining the biological stability of the “milieu interieur” identified by the French physiologist Claude Bernard is the major focus of medical scientists, including immunologists like me who spend our lives trying to work out ways of limiting the toll of infectious diseases. Good health at the level of the subconscious obviously impacts on both our behaviour and on our conscious sense of personal serenity.

“Sustainability” is a comparatively new idea that hadn’t made it to the word list in my 1996 Pocket Oxford. The on-line Merriam Webster definitions include: “relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged; relating to a lifestyle involving the use of sustainable methods”. Harvesting implies the management of resources, which in turn relates to activities like agriculture and mining.

The archaeological evidence indicates that humans first organized into agricultural communities some 10,000 or so years ago. Evidence of copper mining has been found to date back at least 7,000 years. Given that *Homo sapiens* is thought to have been on the planet for about 120-150,000 years, both the impact of our species and our methods of food production and metals-based technology are very recent features of the global landscape. By contrast, the adaptive immune system that protects the higher vertebrates from infectious diseases evolved some 350 to 400 million years ago.

At the time of the first European settlement in 1788, Australia provided what was essentially a laboratory of the effect that a pre-agricultural, hunter/gatherer society has on a natural landscape. The Australian aboriginals are thought to have arrived some 50,000 or so years ago. Though there is evidence of very limited contact with people to the north and, latterly with Europeans who shipwrecked on the west-coast, they were culturally isolated and maintained a semi-nomadic lifestyle. Their animistic, patriarchal culture was built around the idea of “The Dreaming”, the oneness of the spiritual, human and natural worlds. By the 18<sup>th</sup> century between 300,000 to one million people were organized into tribal groups speaking 270 or so different languages. Local battles, raiding parties and even long-term feuds are known to have occurred, but they lived mostly in a culture that was defined by kinship, respect, ritual and negotiation.

Despite their affinity for the land, the effect of aboriginal culture on the Australian biota was profound. All the large Australian vertebrates, marsupials, snakes and birds, became extinct about 46,000 years ago. Admittedly, this is guilt by association, but it seems likely that big, rather un-aggressive, slow-moving animals would have provided a primary target for hunter/gatherers. The practice of “firestick” harvesting to drive kangaroos and the like onto the spears of the hunters is thought to have shaped both the biology of the Australian eucalypt seeds that germinate following fire, and the nature of the open grasslands. Still, the aboriginals achieved nothing like the massive erosion problems that followed the clearance of natural forests and the introduction of sheep and cattle, the saltation of soils from flood irrigation or the stripping of both arable and marginal land for real estate developments that European Australia managed within just over two centuries. If human history tells us that we are programmed intellectually to

exploit and degrade our natural environment to the extent that the available technology will allow, it is also starting to acknowledge that we have to change.

The development of agriculture in the northern hemisphere led to stable communities, followed by the evolution of city and nation states. Military technology became important to defend the resources that particular groups had established and accumulated. Building practices developed to provide defensive walls and shelters made of fortified, non-combustible materials. With the emergence of a merchant class it became important to protect trade routes, sources of supply and markets. The written record that begins about 2500 years ago with historians like Thucydides and Herodotus reflects well-established practices that share many features with both the civil and military cultures of today.

War and conquest also had the secondary function of providing cheap labour. As Herodotus tells us, women of both high and low social status were sometimes acquired as wives in the same way. Many of those who were captured became slaves, a practice that ended in most of the western world in the 19<sup>th</sup> century but surfaced again briefly during the 20<sup>th</sup> century in the totalitarian regimes of the Nazi concentration camps and the Soviet gulag. Industrialisation, with all the negative environmental consequences that accompanied it, removed the necessity for people to be either slave owners or to be enslaved.

At the beginning of the 20<sup>th</sup> century, the total size of the human family stood at about 1.6 billion, an increase of 4-5 fold over a period of 2,000 years. By 2001, the number of human beings on the planet had increased by a further factor of four to 6.4 billion. Clearly, neither the earth nor human civilization can sustain persistent growth at this rate. The remedy to the numbers quandary is obvious. In scientific terms, the experiment has already been done. The combination of prosperity, contraception and social security mechanisms that provide both health care and retirement benefits has caused the rate of natural population growth in many of the western democracies to fall below replacement values. Any increase in these countries is a consequence of immigration. At the same time, words like “ecology”, “environmentalism” and “sustainability” that were almost totally absent from public discourse more than 40 years ago now have major political resonance.

Europe, in particular, is paying much more attention to the development of “clean and green” approaches. This reflects, I believe, a broad political consensus that we cannot continue with technologies that compromise the natural world. Though the environmental movement is also strong in both the USA and Australia, this has yet to translate into a major effect on the political landscape in these less densely populated land-masses. Neither country has experienced anything as dramatic as the poisoning of the Rhine that occurred in the mid 1980’s, or the widespread dispersion of radioactivity that followed the Chernobyl disaster.

The idea that it is essential to stabilize population size is regarded with hostility in some quarters. Religious leaders may see population growth among the faithful as essential for maintaining their authority and power. Politicians and economists are concerned at the Nation State level about how it will be possible to maintain current retirement ages and pension schemes with a declining working population and tax base. As people live longer it becomes necessary to extend the definition of a normal working life. It is interesting to watch this dynamic play out in Australia where, as recently as 20

years ago, many were being encouraged to retire very early. Democracy, for all its advantages, is not good at long-term planning. Any proposal to increase the mandatory working life required to qualify for government social security benefits is, of course, politically unpopular. A very human characteristic is to develop a strong sense of entitlement very rapidly indeed. Despite the “back to the past” scenarios played out on some TV “survivor” programs, few in the advanced world seem to have any real consciousness of the harshness of life as recently as 100 years ago.

The capitalist model that drives prosperity thrives under conditions of continued building, development and expansion, all of which are driven by population growth. The role of human beings in a contemporary western culture is increasingly to be consumers rather than manufacturers. The essential equation is obvious: the more people the more consumers. Planned obsolescence and technological advances sustain demand. A massive advertising industry works tirelessly to convince people to buy new, or improved products. Though a move to the consumption of computer software and other “mind-related” products might be expected to diminish pollution, the fact is that prosperity is still very much tied to the sale of large, complex durable goods like motor cars. Ideas like “back manufacturing” and designing products from the outset so that they can be recycled, or even reused, can undoubtedly help to diminish the negative environmental impact. Maintaining prosperity requires that we focus on innovative, non-polluting technology, while at the same time creating demand for experiences and products that are not environmentally destructive. Modern electronics moves us in this direction.

While this has been happening for some time in what is generally described as the “advanced world”, the “aspiring world” that emerges increasingly as a consequence of globalization and the internationalisation of both e-business and the manufacturing industries is set on the same path. The positive side of such prosperity should be the stabilization of population size. The negative is that environmental pollution will increase dramatically unless new approaches and technologies are developed and adopted. Though enlightened leaders may have this in mind, the problem is both the cost and achieving the balance between what should be done and the needs of both individuals and communities who still depend economically on old and polluting equipment, work situations that are environmentally unfriendly, clear cutting forests and so forth. Television creates the expectation that everyone should be able to drive around in gas-guzzling 4-wheel drive “sport utility vehicle” without addressing the environmental consequences of such behaviour. Perhaps a TV program that focused on sitting in traffic on a Los Angeles freeway might help, though it would probably fail to attract a very big audience.

Part of the problem is that the enormous success of our modern, science-based culture has led to the widespread assumption that there will always be some sort of technological fix. Why diet when we can achieve the same thing by taking a pill? So what if the oil runs out, hydrogen will solve the problem. It still takes energy to make the hydrogen. The more widespread use of nuclear power is waiting in the wings. Strangely, though many in the broader community are suspicious of science, they at the same time have a confidence in the power of science to solve any and every problem that is not shared by many of the practitioners. The fact of the matter is that science does some things very well, and others not so well. A stark example is the new A380 Airbus. This magnificent, massive machine with its sophisticated electronics and control systems burns oil, fossil fuel. Solving the energy equation in an environmentally friendly way

may, in the long-term, be the biggest single contributor to world peace and sustainability. This will not be easy.

What we have come to realize is that the hardest, single thing to achieve is to change cultural practices and belief systems. Education is the key, but building the type of physical resources and social mix that allow broad-based information and education systems to operate is a major challenge, especially when the media is increasingly controlled by corporate entities that can have a somewhat different agenda. Even in the advanced democracies it can be very difficult to bring voters to the point where long-term concerns influence the political process. Though we love our children and grandchildren and would do nothing to harm them, we are much more careless when it comes to protecting the physical world that they will inherit. The situation is quite different when the danger is immediate and obvious. The British, for example, still look to the sacrifices that they made to defeat Nazism as their finest hour. Once a sufficient threat is perceived, it is part of our normal biological response profile to mobilize rapidly to counter the danger.

A great example that will be very familiar to you is the extremely effective response that Thailand made to the AIDS pandemic. In the mid 1980's, I was visiting Bangkok regularly as part of a WHO committee that was evaluating a prototype dengue vaccine. The emerging situation with AIDS was on everyone's mind but, in those early days, many had the sense that it would not impact heavily on this country. As you know, that perception proved to be completely wrong. What is so impressive is that, once the magnitude of the problem was recognized, Thailand organized rapidly to limit the spread of the human immunodeficiency virus (HIV). My understanding is that all elements of civil, military and religious authority came together to advocate the necessity for behavioural change including the use, and ready availability, of prophylactics.

What impact does infectious disease have on the peace/war equation? Both the handling of the SARS epidemic and the response to the ever-present threat that a variant of the highly lethal H5N1 avian influenza A virus might start to spread in human populations emphasize how different Nation States and international agencies work effectively together when there is a major, and immediate danger. People co-operate and do what is necessary. The impact is not as sudden and dramatic as a Tsunami, but a virulent respiratory infection that spreads rapidly can be extremely dangerous. The global influenza pandemic of 1918-1919 is believed to have killed between 40 and 100 million people. Though it was not admitted at the time, influenza undoubtedly contributed to the cessation of WWI as many of the soldiers in the trenches were infected. The disease was known initially as the "Spanish flu" because Spain, which was not a combatant country, acknowledged that there was an emerging problem.

Conversely, it is also possible that the 1918-1919 influenza pandemic helped to establish the conditions that led to WWII. The competing views at the Versailles peace discussions were that Germany should pay massive reparations to the victorious allies or that, in the spirit of the initial armistice agreement, there should be a more moderate arrangement that would allow general economic recovery on both sides of the former divide. The French Prime Minister Georges Clemenceau favoured crushing Germany with harsh reparations, a view that was shared by many nations in the old British Empire. Prime Minister "Billy" Hughes of Australia was a particularly forceful advocate of the retribution scenario. On the other hand, the US President Woodrow Wilson believed that

the basic need was to re-build Europe. The fact that Wilson caved-in is thought to reflect that both he, and his principal advisor, were severely compromised by influenza infection at different stages through the debate. The disastrous economic situation in 1920's Germany that resulted from the adoption of Clemenceaus's policies led directly to the collapse of the liberal Weimar Republic in Germany, the rise of Hitler and the murder of more than 10 million people in the Nazi death camps. The lesson was learned, and the end of WWII was followed by positive initiatives like the Marshall Plan in Europe and the economic reconstruction of Japan fostered by the US commander in the Pacific, General Douglas MacArthur.

The key characteristic of influenza is that the period of severe respiratory compromise is acute in onset and, providing the adaptive immune system does its job and eliminates the pathogen before too much damage is done, the individual recovers completely and will not again be infected with that particular virus. The effect is like a commando raid that can kill, but otherwise causes only a temporary disruption of normality. The problem with influenza is both that the pathogen mutates readily within human populations as a consequence of antibody-mediated selection pressures, and that there is a reservoir of closely related viruses in other species.

Because the influenza virus has a segmented genome, a chance, simultaneous infection of a person with both a bird and a human strain can lead to a "repackaged" virus that is part bird, part human, and looks completely novel to the human immune system. We know how to make protective vaccines, and there is an extremely effective, global influenza response network that is co-ordinated by the WHO in Geneva. The difficulty is to decide which influenza virus is likely to be circulating in the coming year, then to produce the necessary vaccine in sufficient quantities. The main danger is that a new, rapidly spreading, virulent virus could cause enormous damage before the right vaccine becomes available. The saving grace is that we also have an effective anti-influenza drug, though there are logistic difficulties in both the method of use and in ensuring a sufficient supply. Some nations are maintaining drug stock piles to protect, at least, their medical professionals.

The biggest challenge that immunologists face is to defeat the systematic subversion, or avoidance, of immune control by some forms of cancer and by microbial diseases like tuberculosis (TB) and malaria that invade, and then persist in the face of an otherwise healthy host response. The worst such infection is HIV, which induces a slow death as a consequence of the progressive, inexorable destruction of the immune system that normally operates to defeat parasitism and maintain biological integrity. The potential for the current, continuing HIV pandemic to compromise world peace is also both immediate and obvious.

According to a briefing document prepared by Richard P Keeling MD ([www.rkeeling.com](http://www.rkeeling.com)) the number of deaths from AIDS globally in 2002 was estimated at 3.1 million, including 1.2 million women and 610, 000 children. Approximately 5 million became infected during 2002, giving a total of more than 42 million with the disease. The regional breakdown included 29.4 million in sub-Saharan Africa, 6 million in south and southeast Asia, 2.1 million in eastern Europe and Russia, 980,000 in North America and 570,000 in Western Europe. There is no reason to think that the global rate of new cases is declining. Many infected people in countries like the USA are, of course, now living longer and relatively normal lives as a consequence of the development of effective anti-

viral therapies. Efforts are being made to distribute lower-cost, generic versions of these drugs more widely.

Every attempt so far to develop an AIDS vaccine for use in the poor, “mired” countries of the world has been extremely disappointing. The research is continuing, and a number of very talented scientists are working on this immensely difficult problem. Organizations like the Bill and Melinda Gates Foundation continue to make an extraordinary commitment to the development of effective counter-measures. The experience in Thailand, Senegal and Uganda, tells us that it is possible to promote behavioural change, including the use of condoms. Otherwise, the best, short-term strategy may lie with the further development of topical preventives, ranging from lemon juice to various microbicidal preparations that women can use to protect themselves.

Unlike influenza, HIV is not particularly contagious and many remain uninfected after numerous sexual contacts. However the rules of random chance and the lottery apply: transmission can occur after one or 500 encounters. Injection on a blood-contaminated needle gives, of course, a much higher probability of contracting the disease. The initial symptoms may be those of a transient, influenza like infection followed by apparent recovery. The person may feel reasonably normal, but there is a continuous, raging battle between the various elements of the adaptive immune system and the virus, which has the capacity to change rapidly, escape from control and persist within the individual. The lymph nodes and spleen are war zones. Eventually, the immune system is effectively destroyed.

The wasting disease characteristic of AIDS then results from the “break out” of other viruses like the lymphoma-inducing Epstein Barr virus (EBV) or Kaposi’s sarcoma virus. Almost everyone is persistently infected with EBV, the cause of infectious mononucleosis in adolescents, but most carry it through life without any untoward effect. People with AIDS become very susceptible to major diseases like TB. Even “commensal” organisms, like *Pneumocystis*, that normally live on our mucosal surfaces but do not invade, can cause generalized infection and death.

The progressive compromise of inner biological harmony results primarily from the elimination of the CD4<sup>+</sup> T cells that are the primary target of HIV infection. This category of lymphocytes, or white blood cells, normally functions both as “effectors” to limit the emergence of latent viruses like EBV and as “helpers” to promote the quality and magnitude of the antibody and the CD8<sup>+</sup> “killer” T cell responses. The protection afforded by most vaccines is mediated via circulating antibodies, while the CD8<sup>+</sup> T cells are “hit men” that operate normally to “bump off” virally-infected cells.

The way that HIV works biologically is almost a mirror of the social consequences of this terrible disease. AIDS eliminates the helpers and effectors in society. The worst damage to date has been in sub-Saharan Africa. High mortality rates among school-teachers, political leaders, police officers and public officials have devastating consequences. Many children have lost both parents and, if they are lucky, are being raised by grandparents. Farmers die before they have the chance to pass on the skills needed by the next generation. Such widespread disruption of the social organism may also decrease resistance to malevolent trends that are always present but are normally controlled. The potential for the emergence of extremist fundamentalism and both local and global terrorism is of obvious concern to security organizations worldwide.

In general, the response of the advanced countries to the AIDS pandemic is largely, though not totally, altruistic. The big mining companies that operate in heavily infected nations like South Africa are at the forefront of efforts to provide the behavioural counselling and drugs that will help to ensure the continuity of an effective work force. This may seem to reflect self-interest in one sense, but think how positive it would be if that approach was to be extended to all members of the “globalised” work force. If we are to defeat AIDS, those that pursue solutions in basic science, public health and education must work together with religious, political and business leaders to marshal every possible resource against this terrifying disease.

The influenza viruses and HIV evolve under the selective pressure of immunity to select “escape” variants that allow them to replicate and to spread, a process that ensures their own survival. A mutant influenza virus that kills too quickly will minimize the possibility of transmission and increase the likelihood that it will be a biological “dead end”. On the other hand, mutant HIV viruses have the potential to be transmitted over long periods. There is always the fear, for example, that a “high transmission” variant of HIV might emerge.

The comparable, Darwinian selection of mutant cancer cells also allows escape from growth-control and the maximization of the tumour’s biological “success”. What the “selfish genes” of the tumour cannot “know” of course is that their ultimate triumph ensures both the death of the host that supports them and their own destruction. No complex entity can, in the end analysis, survive without operating in ways that ensure the overall health and sustainability of the system. Economic growth is likely to be most beneficial when the drive of individual entrepreneurs is balanced by appropriate controls and the educated concerns of the broader community.

Drawing analogies between biology and social practice is, of course, a somewhat dangerous game that needs to be tempered by a strong sense of both law and ethics. Darwinian natural selection in say, HIV or influenza infection, is a mechanistic process that operates way below the level of consciousness. Though natural selection remains at the heart of modern biology, the application of perverted ideas of “social Darwinism” led to some of the worst abuses of the 20<sup>th</sup> century. Tax policies that emphasize the “survival of the fittest”, or social engineering initiatives that reject the “unfit” by sending this person to the left, another to the right, in some form of Auschwitz-like selection process find no intellectual justification in evolutionary biology.

While we must be conscious of biological imperatives, our progress as a species has reflected a capacity to bypass natural controls and limitations. The task now is to develop novel solutions that achieve a better balance with both our environment and the rest of the biota. The challenge that faces humanity through the 21<sup>st</sup> century is to generate broad agreement on a workable “ethics of sustainability” while at the same time extending the opportunity for many more people to live high quality lives. Along the way we may wish to refine what some of us mean by “quality”. At the same time we need to maintain, and even enhance, our sense of basic integrity as compassionate and moral beings. Perhaps, if the 20<sup>th</sup> century was the age of science, the best scenario for the 21<sup>st</sup> may be to facilitate a process of cultural evolution towards equitable, ethical solutions and sustainability.

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