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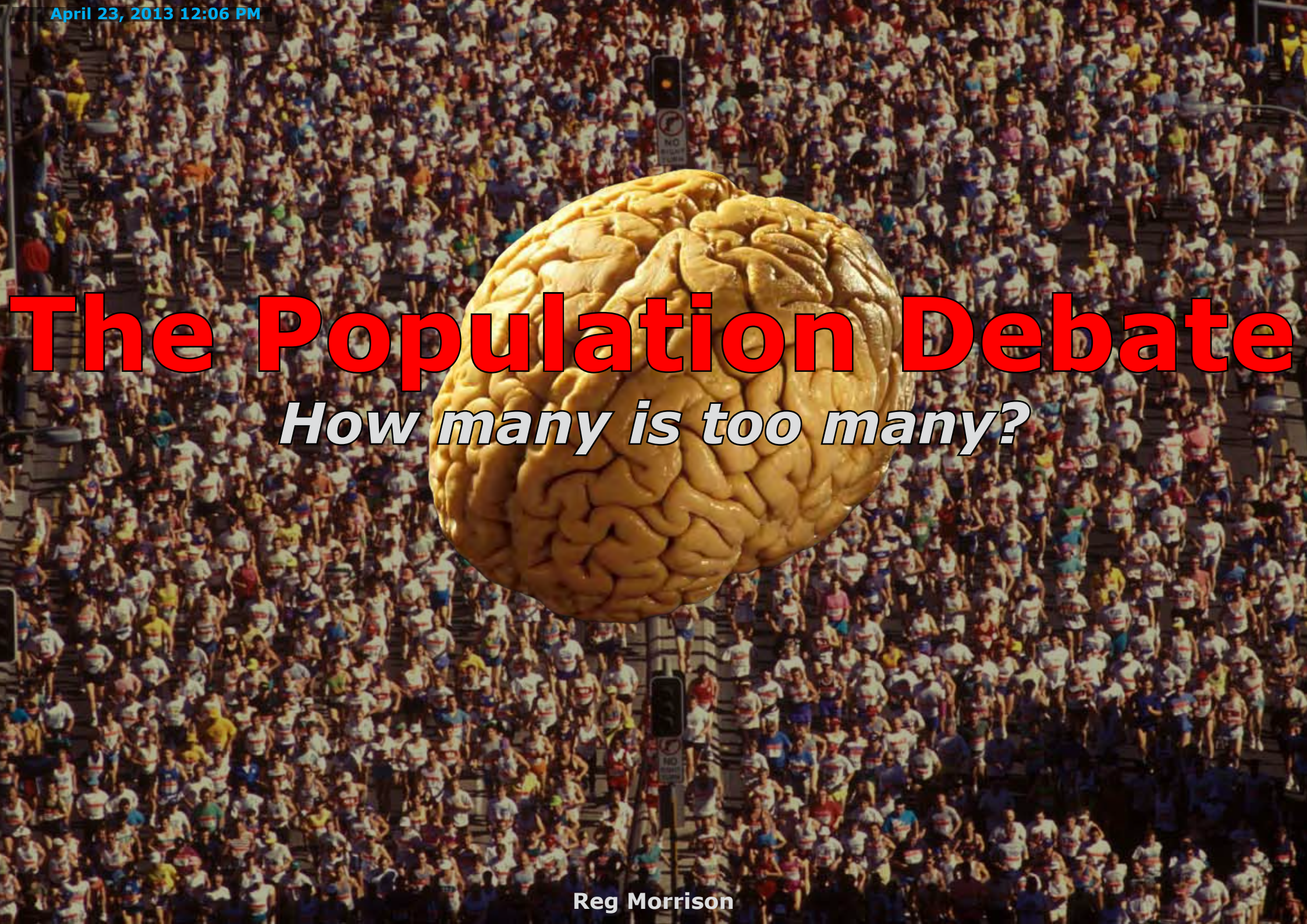


The Population Debate

How many is too many?

Reg Morrison

The Population Debate

POSITIVE ARGUMENT

‘A culture’s greatest asset is its people.’

Those who advocate population growth tend to be politicians, economists, systems analysts and professors of business administration ...

According to traditional economics, a culture’s best asset is its people. They are the source of the muscle, money and ideas that make cultures strong and resiliant. Continual moderate economic growth is the factor that enables people to maintain social cohesion and flexibilty during population growth.

NEGATIVE ARGUMENT

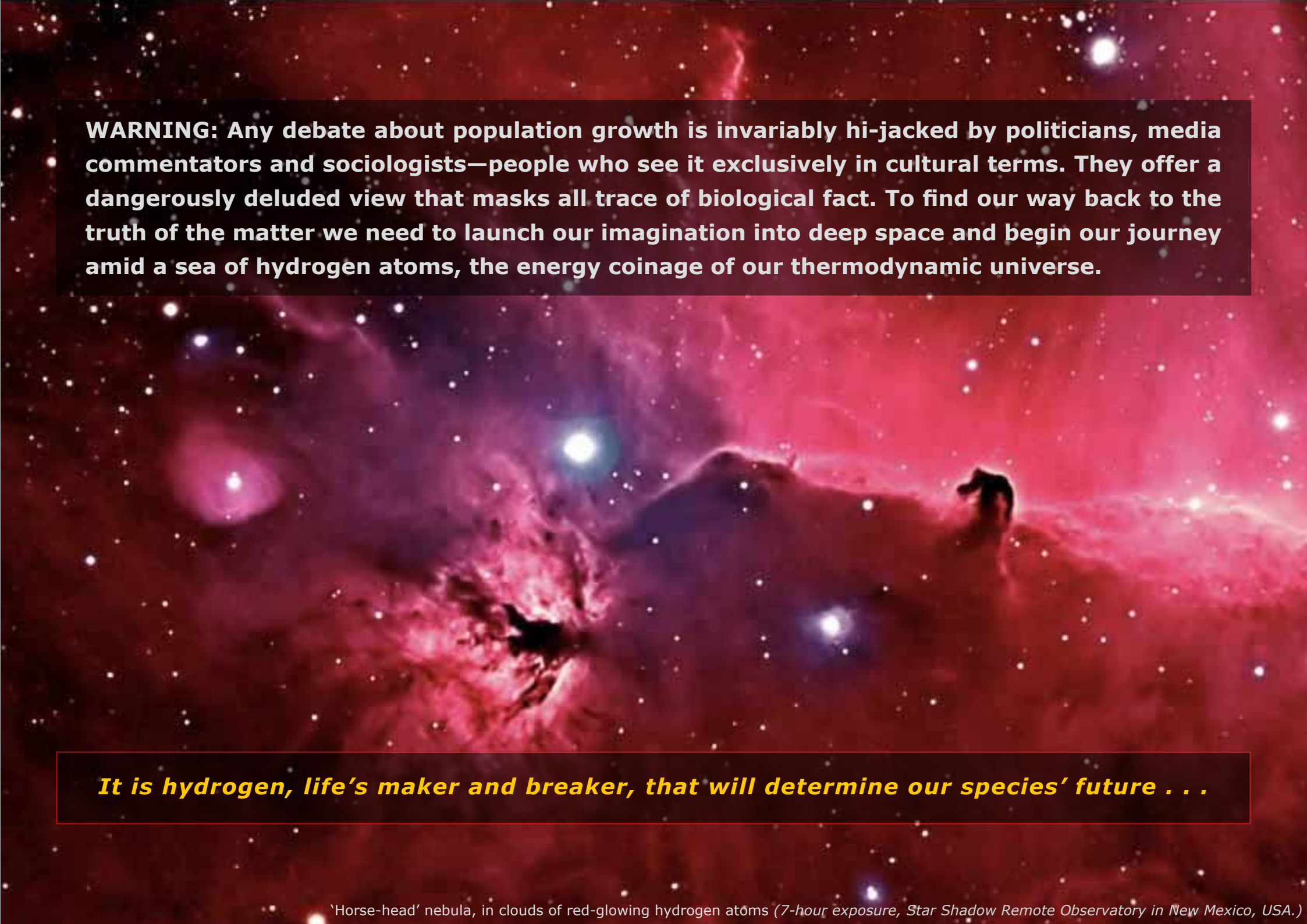
‘Our planet is already overpopulated.’

Those who oppose population growth tend to be biologists, earth scientists, conservationists and environmental journalists ...

According to environmental evidence our planet is already overpopulated and requires a second Earth-like planet to supply the food, fuel and other resources that we need. And since most of these resources are finite and our population is still growing, we will soon face a global crisis due to energy and resource starvation.

THE REAL DEBATE SHOULD BE ABOUT ENERGY

All life is energy dependent. As part of the cosmos and in accordance with the rules of thermodynamics all life must maintain a fine balance between its energy harvest and habitat damage due to the extraction and disposal of its energy-laden waste. Disproportionate energy extraction and disposal guarantees extinction.



WARNING: Any debate about population growth is invariably hi-jacked by politicians, media commentators and sociologists—people who see it exclusively in cultural terms. They offer a dangerously deluded view that masks all trace of biological fact. To find our way back to the truth of the matter we need to launch our imagination into deep space and begin our journey amid a sea of hydrogen atoms, the energy coinage of our thermodynamic universe.

It is hydrogen, life's maker and breaker, that will determine our species' future . . .

'Horse-head' nebula, in clouds of red-glowing hydrogen atoms *(7-hour exposure, Star Shadow Remote Observatory in New Mexico, USA.)*

HYDROGEN: the maker and breaker of life

- **The universe is a thermodynamic system that is entropic (running down).**
- **The primary energy courier throughout the universe is hydrogen.**
- **Hydrogen fires the stars, enables genetic replication, and thereby generates life.**

1. ENERGY

Biological existence requires a flow of energy, primarily via hydrogen, and all species are energy dissipators. A species' energy budget must remain within a range that is appropriate to its bodymass and fertility rate, given its particular form, function and habitat.

2. REPRODUCTION

Reproduction ensures genetic survival, but it is also very energy expensive. So the two factors are unavoidably linked. It means that an increase in a species' energy consumption invariably leads to an increase in its rate of reproduction, and vice versa.

*Just as inadequate reproduction leads inevitably to extinction, unbridled reproduction leads to exponential population growth that outpaces the ability of the environment to replenish itself. The population then peaks and collapses due to starvation, disease, an accumulation of toxic waste, and a growing number of hormonal, genetic and epigenetic dysfunctions that are collectively known as Selye's General Adaptation Syndrome.**

LIFE IS A BY-PRODUCT OF ENERGY DISSIPATION

As a typical by-product of Earth's crustal evolution, our species is entirely regulated by its consumption of gross energy (food and fuel), exactly like the rest of the biota. In an evolutionary sense, harvesting too much energy is just as lethal as harvesting too little of it. Both extremes can result in extinction.

*See **NOTE 1.** Also **APPENDIX 1.** For further information on hydrogen read: "***Life's Maker and Breaker***"

The old axiom that life is carbon-based is misleading.

LIFE IS HYDROGEN-BASED

As an ephemeral expression of the Earth's crust life is an inevitable by-product of the energy gradient that forms the interface between the body of the planet and the matrix of space.

Carbon does indeed provide most of the building material that life uses to construct its mansions, but it is essentially an inert structural element. It is hydrogen that switches the lights on and off inside those mansions.

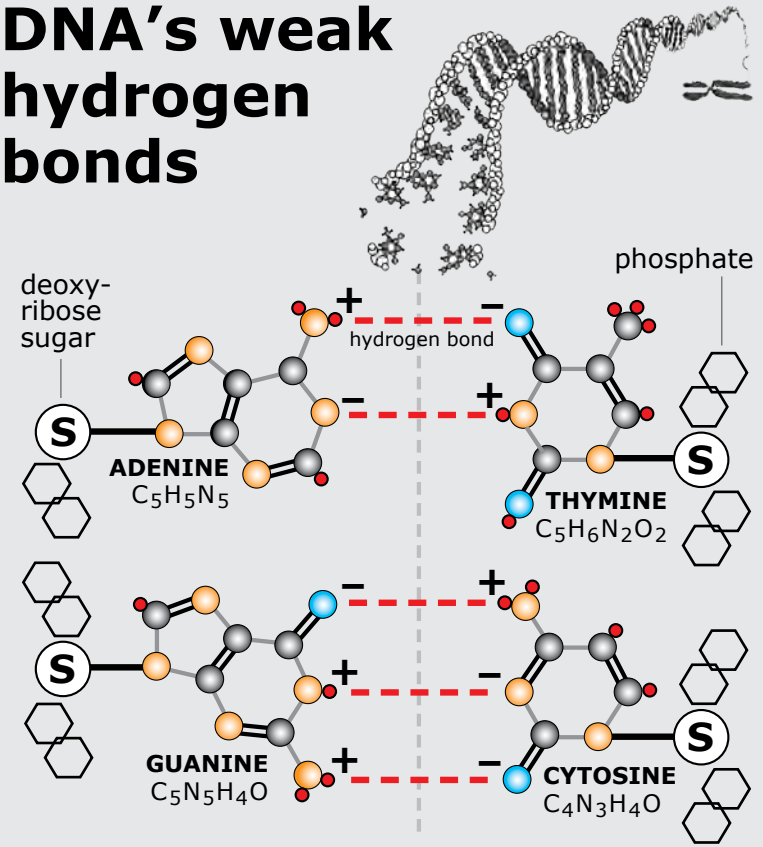
As the smallest and most abundant element in the universe, hydrogen possesses only a single promiscuous electron and forges bonds that are about 5% as strong as any other, and it is this peculiar weakness that makes life possible.

The twin strands of the DNA helix are linked exclusively by these bonds, and it is this inherent structural weakness that enables the double helix of DNA to unzip and reunite repeatedly in order to replicate and yield protein. If those bonds were any stronger DNA replication would become impossible: any weaker, and the DNA strands would fall apart too easily.

A series of hydrogen-loaded carbon tags along the side rails of DNA also helps to regulate this process by controlling how tightly the strands are folded. The attachment of a hydrocarbon tag tends to 'switch off' associated genes. Meanwhile, the pattern of tagging (methylation) is accessible to environmental interference.*

In summary, hydrogen not only fires the stars and lights the universe, it performs a similar role in the moist microcosmos of the Earth's biosphere. And as the primary shaper of our planet's energy gradient, hydrogen is also the maker and breaker of all life and the determinant of population size.

DNA's weak hydrogen bonds



KEY

- Hydrogen atom
- Carbon atom
- Oxygen atom
- Nitrogen atom

As the primary by-product of the Big Bang, hydrogen constitutes 90% of all the atoms in the universe and provides the basic energy coinage for the chaotic entropy of its thermodynamic structures. Hydrogen also forms the basic coinage of all biological energy and provides the weak chemical bonds that hold together the helices of DNA. In short, hydrogen forms and fires not just the stars, but all living organisms.

* See **APPENDIX 3**

ENERGY DISPERSES FRACTALLY

'The Butterfly Effect'

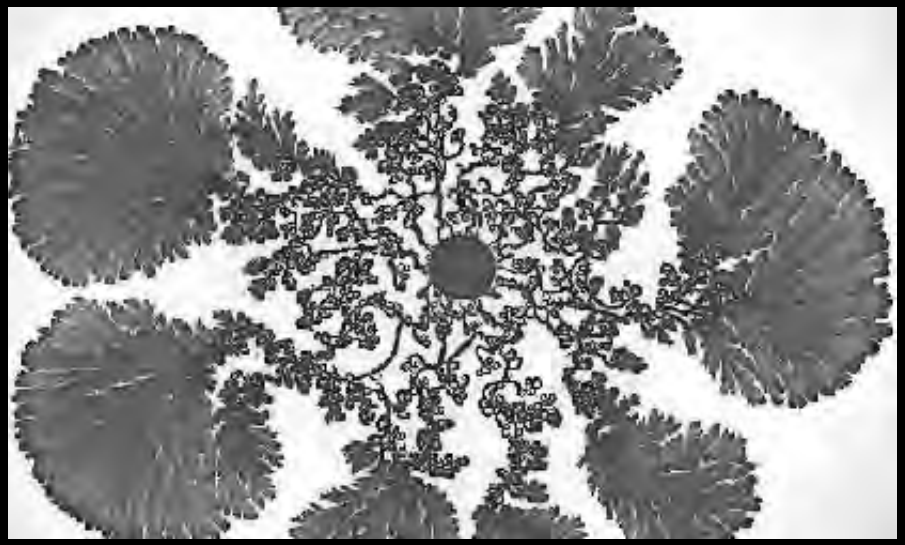
The mathematician and meteorologist Edward Lorenz first formalised his CHAOS proposition in 1963 in a paper entitled "Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?"

In this paper, originally delivered to the American Association for the Advancement of Science, Lorenz proposed that small changes in the starting state of a dynamic energy system could lead to enormous differences in its final state. His paper also proposed that the complex patterns of energy dissipation that characterised such chaotic systems were invariably fractal (repetitive but non-identical).

The truth of Lorenz' proposition has since been repeatedly confirmed, and Chaos is now classified as a Theory and generally accepted as a primary characteristic of our thermodynamic universe. Indeed, Chaos and its fractals reappear wherever energy gradients occur in the cosmos, at all scales of magnitude from the cosmic to the microcosmic. Inevitably too, they characterise all parts of our Solar system and stamp their fractal hallmark into every aspect of the Earth's biosphere.*

As an interchangeable expression of the planet's crust, life itself acts as a crucial cog in Earth's energy-dispersal machinery, and so life too, displays the hallmarks of Chaos and its fractals in every aspect of its existence. And all of it is essentially fuelled by hydrogen.

Humanity offers no exception to this rule.



A bacterial colony (PHOTO: Eshel ben Jacob, Tel Aviv University, Israel.)

Humanity offers no exception to the fractal laws of Chaos Theory.

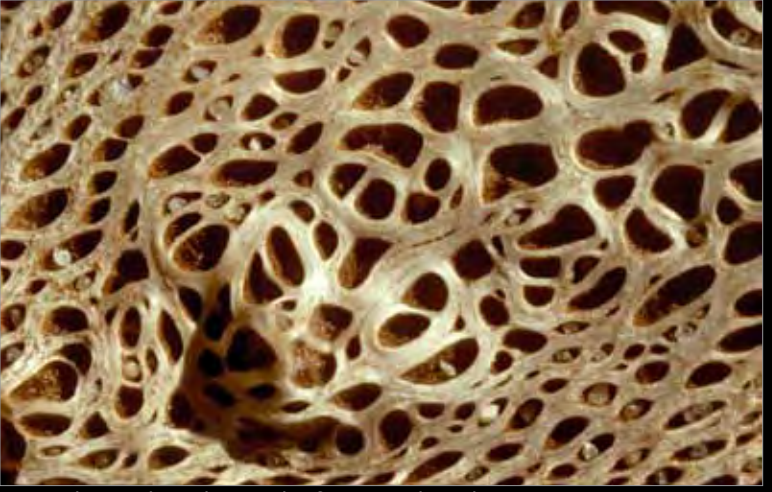
*See also: "***Fingerprints of the Cosmos***"

Via growth and reproduction, all life is inherently Chaotic and fractal

BACKGROUND: Digital fractals by Sven Geier (www.sgeier.net/fractals/indexe.php)

INSET: A fern frond uncurls (Cyathea sp.), Sydney.

Thanks to DNA's weak hydrogen bonds, and to hydrogen extracted from water (H_2O) via photosynthesis, all of Earth's surface life is generated, fuelled and sustained by hydrogen.



Fractal growth in the trunk of a coastal Bankia, NSW.

LIFE IS FRACTAL

Founded on the bacterial extraction of hydrogen, mostly via photosynthesis, the Earth's surface life is an integral part of the planet's energy dissipation machinery. The clearest evidence of this appears in the Chaotically fractal nature of all biological growth and reproduction ...

Treefern frond, *Cyathea sp. NSW.*

A thalloid liverwort, TAS.

Gimlet gum, *Eucalyptus salubris,* WA.

CHAOS: *The Butterfly Effect in action*

FRACTAL ENERGY DISPERSION

The swirls of rainbow colour that drift across a soap film perfectly illustrate the chaotic and fractal nature of energy dissipation throughout the universe.

As a product of the energy loss within the soap film (via evaporation), the flow of colour that characterises its surface accurately betrays the film's changing thickness as it sheds water molecules before bursting.*

LEFT: The evaporation of water molecules from this soap film occurred in perfectly still air. The flow of colours consequently expresses the standard patterns of chaotic energy flow that typify (in two dimensions) the flow patterns that characterise our universe.

RIGHT: This soap film reflects a disturbance pattern in the air surrounding the soap film. (I breathed out just before taking the shot). This minor disturbance to the evaporation process was enough to completely rearrange the film's pattern of energy dissipation.

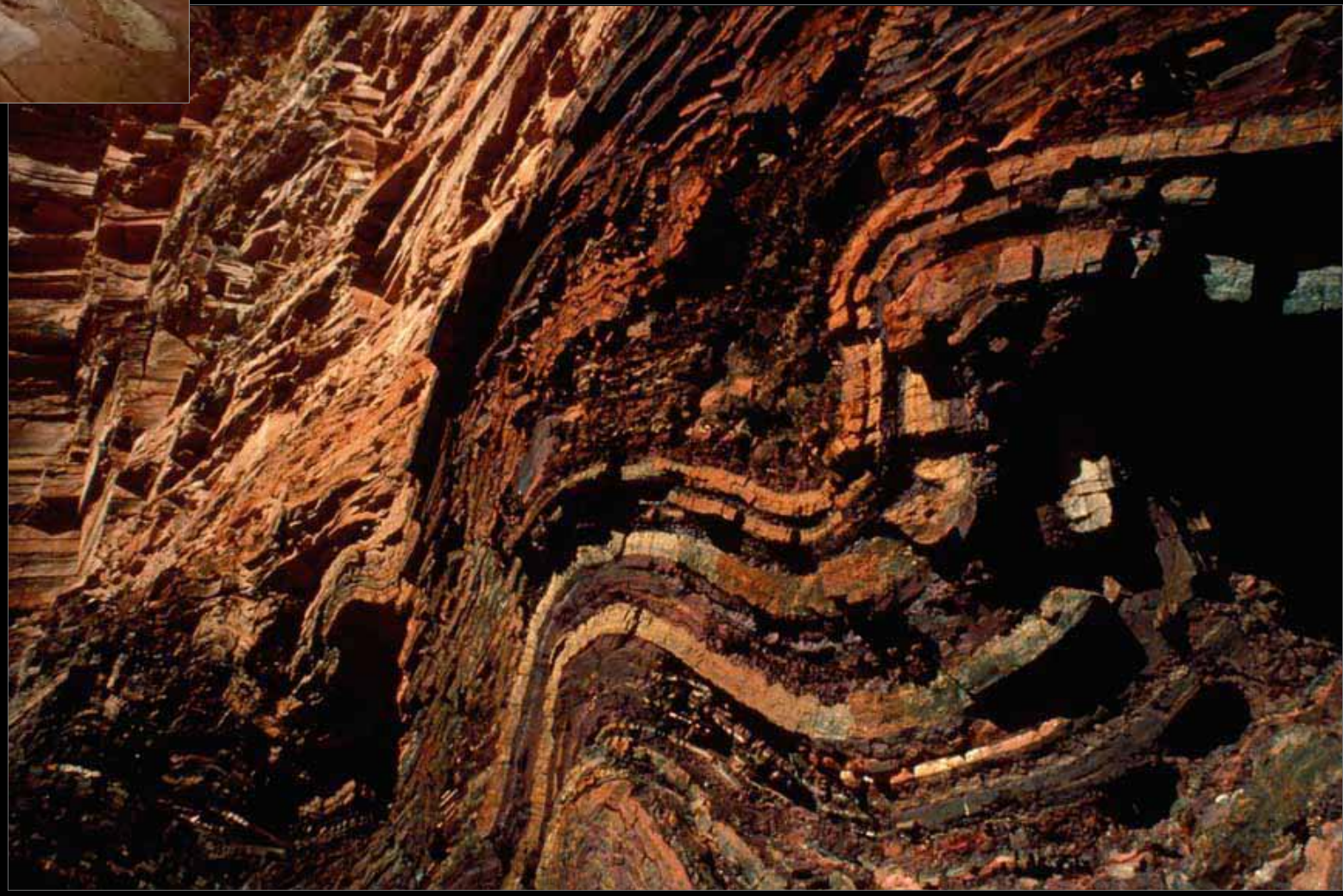
As vehicles of energy dispersion throughout the biosphere, all species must conform to the laws of thermodynamics and live within energy budgets that are appropriate to their form and function, or they face automatic extinction. Our per-capita consumption of energy and resources is vastly greater than that of any other species, past or present, and the energy and wastes that we 'breathe out' consequently distort the Earth's pattern of energy dissipation to a greater degree than has any other species.

*See **NOTE 1**

Hamersley Ranges, Pilbara, WA

This is all that remains of a vast iron seabed several kilometres thick that accumulated as a direct result of photosynthetic bacteria 'breathing out' their oxygen wastes into iron-rich seas. When repeated plagues of those bacteria infested the seas about 2.5 billion years ago the oxidised iron fell to the seafloor in clouds of rusty sediment. This iron now underpins Australia's mineral wealth.

As the only animal species that has ever managed to alter the global atmosphere on a scale approaching those oxygen producing bacteria, we should note well the ominous evolutionary message implicit in this massive environmental fallout.*

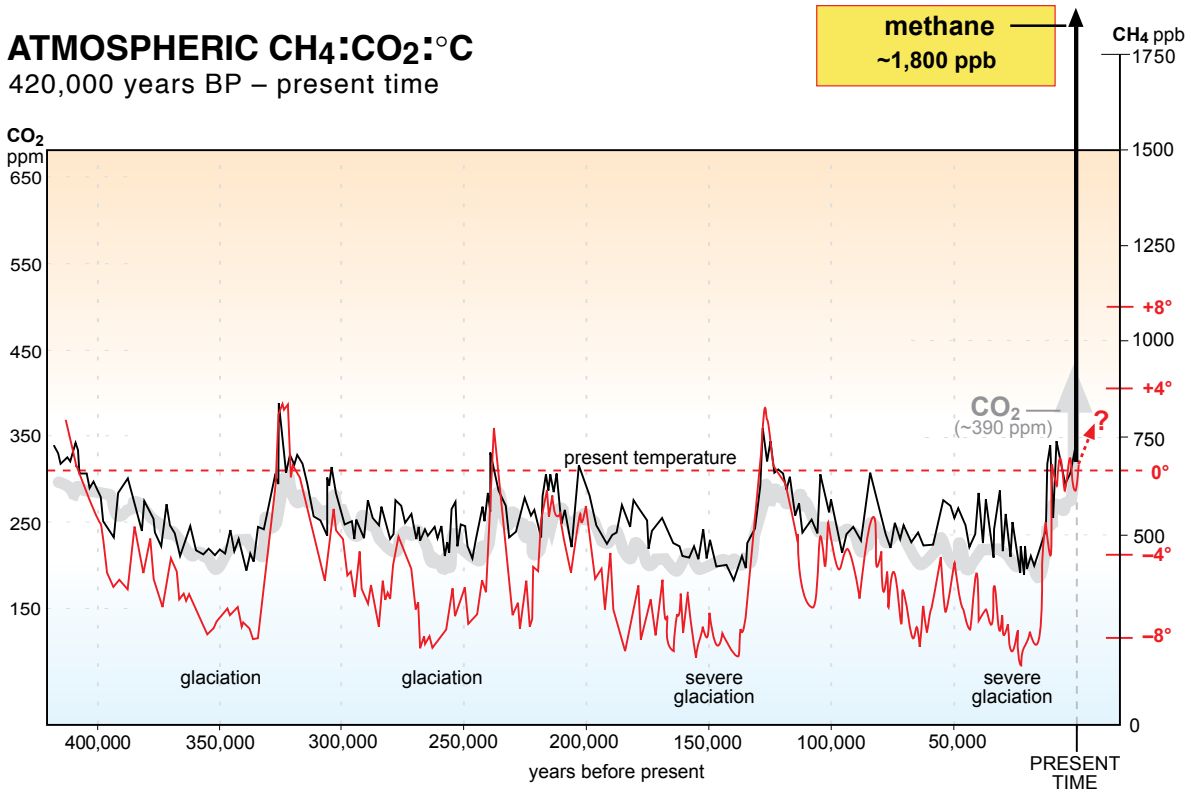


Hamersley Gorge, Hamersley Range, Pilbara, WA

Red Gorge, Hamersley Range, Pilbara, WA

*See also '***The Pilbara: Life's Turning Point***'

Whether you are a bacterium or a human being, any energy that you harvest from the environment ultimately feeds back into the environment and perturbs it—Chaotically.



GREENHOUSE GASES

Atmospheric levels of two key greenhouse gases, methane and carbon dioxide, have varied continuously throughout the life of the planet and their fluctuations have generally coincided with changes in global temperature. Higher levels coincide with higher temperatures.

Methane is now at its highest level for at least 400,000 years and that level is climbing fast.

Although carbon dioxide is more abundant, it is now known that methane is at least 60 times more effective as a greenhouse gas when measured over a short period such as 20 years, and about 100 times more effective over 5–7 years.

This savage short-term effect is partly due to hydrogen's tendency to react with other atmospheric components in ways that multiply methane's potential as a greenhouse gas.*

Atmospheric carbon dioxide has risen 36% during the past 150 years, but during that time the level of atmospheric methane has more than doubled. It is now at its highest level in 400,000 years. The above graph shows the tight correlation between temperature spikes and the methane spikes. This suggests that the most immediate threat to our survival on this overloaded planet is not carbon dioxide … it is methane.

* For further information read: **"Methane"**

Humanity's Impact on the Biosphere:

IMPACT = Population x Affluence x Technology (I = PxAxT)*

POPULATION

12,000 years ago:	5 - 6 million
Present time:	about 7 billion

AFFLUENCE

12,000 years ago:	nomadic hunting and gathering
Present time:	agricultural-industrial (50% urban)

TECHNOLOGY

12,000 years ago:	fire (sole energy source)
Present time:	multiple sources, including nuclear fission and fusion.

MODERN IMPACT = hunter-gatherer impact x 2,400,000 (approx.) *

Human culture flourishes or declines in direct proportion to the average per capita energy, including nutrient, that its members extract from the environment. A civilization is therefore defined by the gross energy that its members consume in their pursuit of sustenance, shelter, reproduction, possessions, entertainment, and personal and cultural security. (WHITE'S LAW)

*See **NOTES 3 and 4**

HUMAN IMPACT

12,000 ago — present time *

POPULATION

(~ 5 million)

Last of the nomads, Jigalong, WA

About 7 billion
(growth: 0.84%/year)

Sydney, NSW

AFFLUENCE

An Aboriginal mia mia, NSW

New York, NY

TECHNOLOGY

Aboriginal firesticks and holder, NT

Hydrogen-bomb test 'Dakota'. Bikini Atoll, 1956.

100 Suns: 1945-1962. Ed: Michael Light. London: Jonathan Cape, 2003. Originally taken by US Air Force 1352nd Photographic Group.

* For comparative energy consumption see **NOTE 4**

HUMANITY'S ECOLOGICAL FOOTPRINT*

(our per-capita impact on the planet)

The Earth has a surface area of 51 billion hectares (510 million square km). About 71% of this surface is covered by seas, and of the rest, only 8.9 billion hectares (each the size of an average soccer field) are biologically productive. In other words, the productivity of each of these hectares matches or exceeds the world average. The other 5.6 billion hectares are either marginally productive or wholly unproductive. The biologically productive hectares are called 'Global hectares' (Gha).*

On average, it takes 2.1 Gha to support each of the ~7 billion people that now inhabit the planet. So 2.1 Gha is the average 'Footprint' of a single human. The total population therefore requires almost 14.5 billion Gha to support it, whereas the planet has only 8.9 billion Gha available. These 8.9 billion hectares represent the Earth's current carrying-capacity for modern humans.

It would therefore take more than 1.6 Earth's to meet our present energy and resource requirements, and our species has over-shot Earth's carrying capacity by more than 55%. These excess consumers have been added since 1980 when the global population was about 5 billion and barely sustainable at their average rate of consumption.

Meanwhile, the global population is still growing and our per-capita consumption levels continue to increase ...

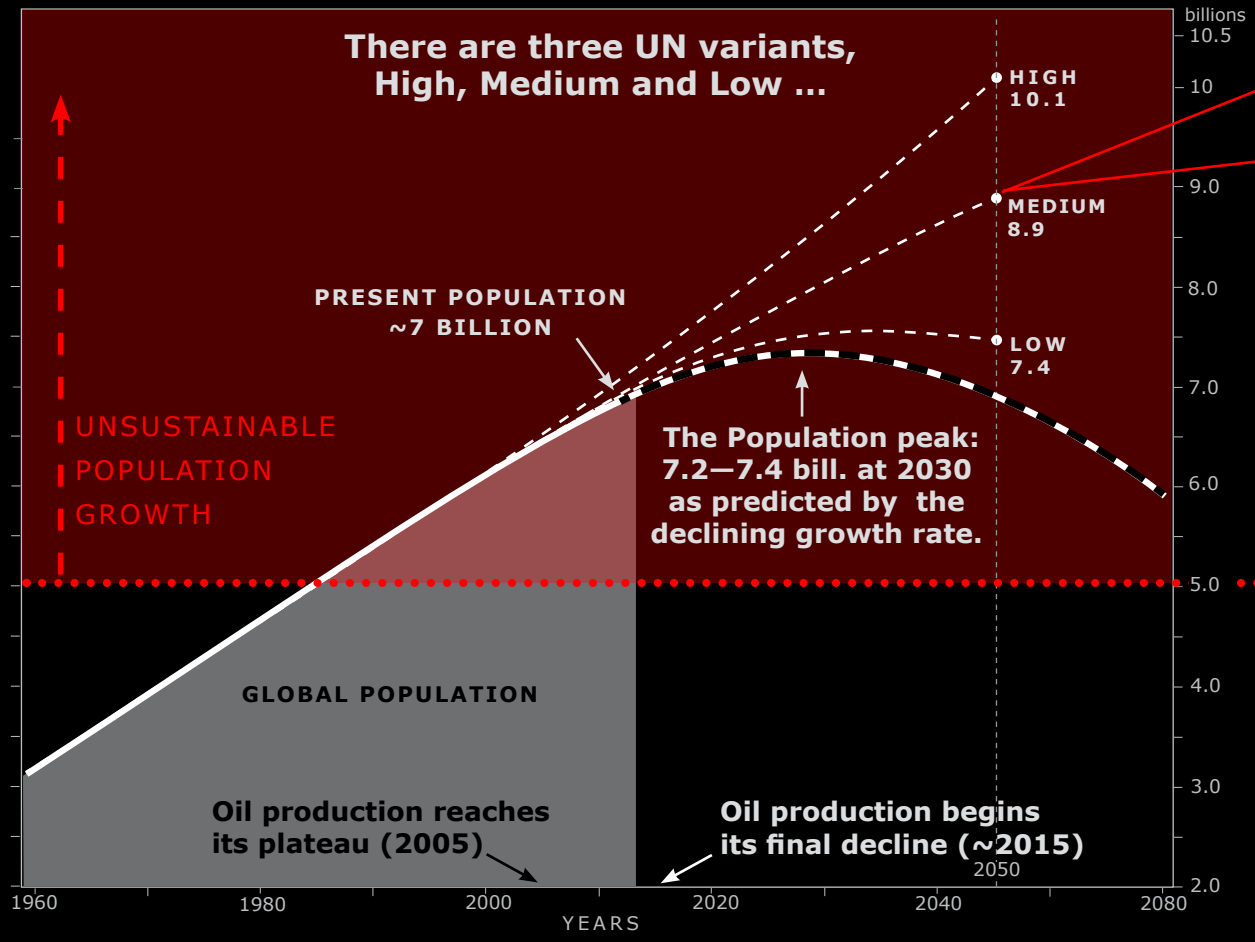
OUR GIGANTIC ENERGY DEBT

Since the energy and resources consumed by our species already amounts to more than 1.6 times the bio-capacity of the entire planet, this means that we are consuming its 'renewables' almost 1.6 times faster than the Earth can replenish them. In economic terms, we are asset-stripping our cosmic home and shrinking its carrying capacity on a daily basis. If this growth in population and energy consumption continues, by 2050 we will need the combined resources of two Earths, just to sustain our population at its present level of consumption. Our species will then be ecologically bankrupt and primed for a swift extinction.

*See **NOTE 2**

GLOBAL POPULATION GROWTH

United Nations' population projections



If the global population keeps growing at the rate predicted by the UN's Medium variant our species will need the resources of two Earth-like planets by 2050, just to maintain our current life styles.

Our species was barely sustainable by the mid 1980s when the global population reached five billion. Beyond that point we began systematically asset-stripping the planet.

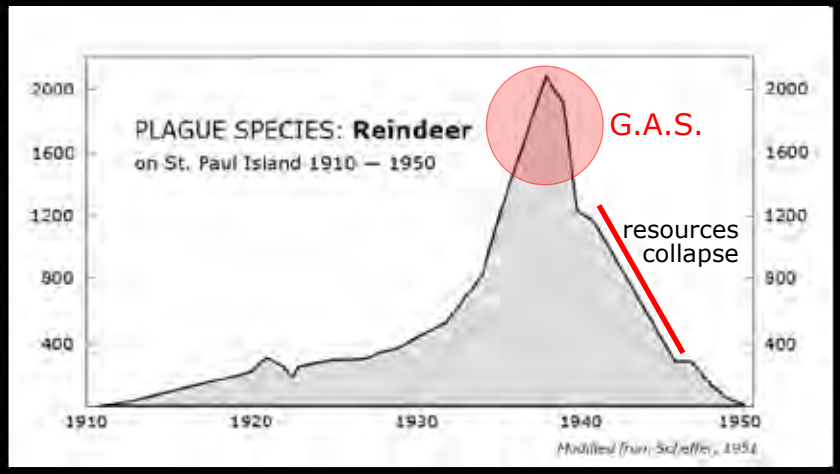
*In 1961 the Earth's productive regions could have supported double the global population of three billion. Since then, accelerating urban sprawl, rapacious over-harvesting of the ocean, escalating pollution, the loss of forests and the erosion and impoverishment of soils caused by the Green Revolution have reduced Earth's human-carrying capacity by about one billion.**

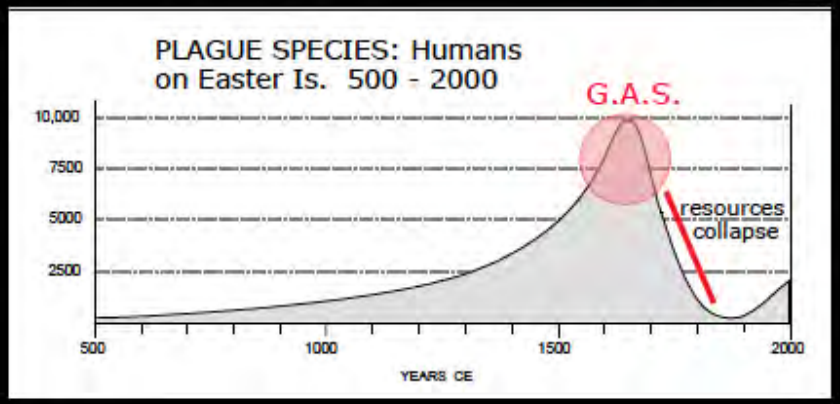
EVOLUTION'S AUTOMATIC PLAGUE LIMITER (G.A.S.)

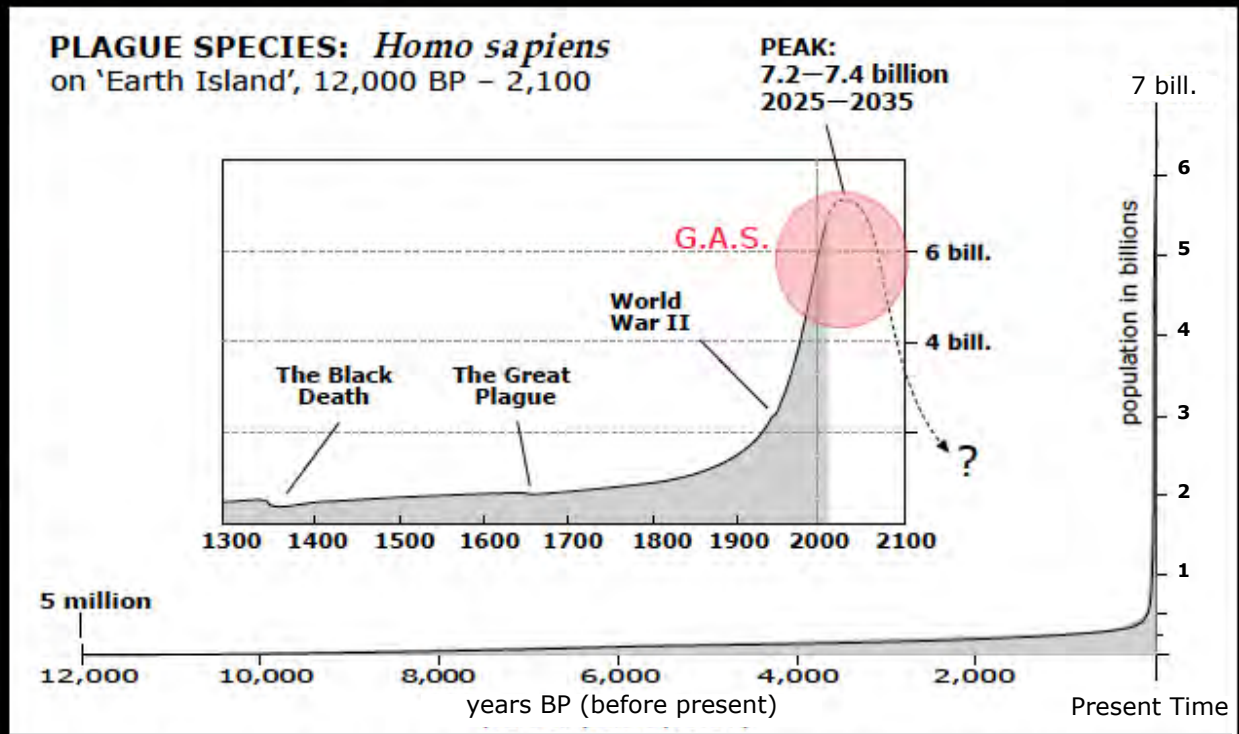
Exponential population growth by a highly successful species threatens the survival of other species that share its habitat and compete for its energy resources. Inevitably, an automatic plague-limiting device has evolved. It consists of a combination of hormones, enzymes and epigenetic switches that interact to bring exponential growth to a halt and reduce the fecundity rate below replacement level.

This little-known brake cuts in well before the environment collapses and food shortages launch the the final culling process. Known as the General Adaptation Syndrome, this evolutionary safeguard was first detect in rodents and defined by Canadian endocrinologist Hans Selye in 1936. He realised that this was stress-related response to exponential population growth, and his data showed that it occurred regularly in rodents, both in the wild and in laboratory populations. It later became clear to him that it also applied to many other species, especially humans.

By applying an automatic brake to exponential population growth during an animal plague the General Adaptation Syndrome (GAS) imposes a crucial upper limit to the degree of damage that such events might otherwise inflict on the regional biota.*

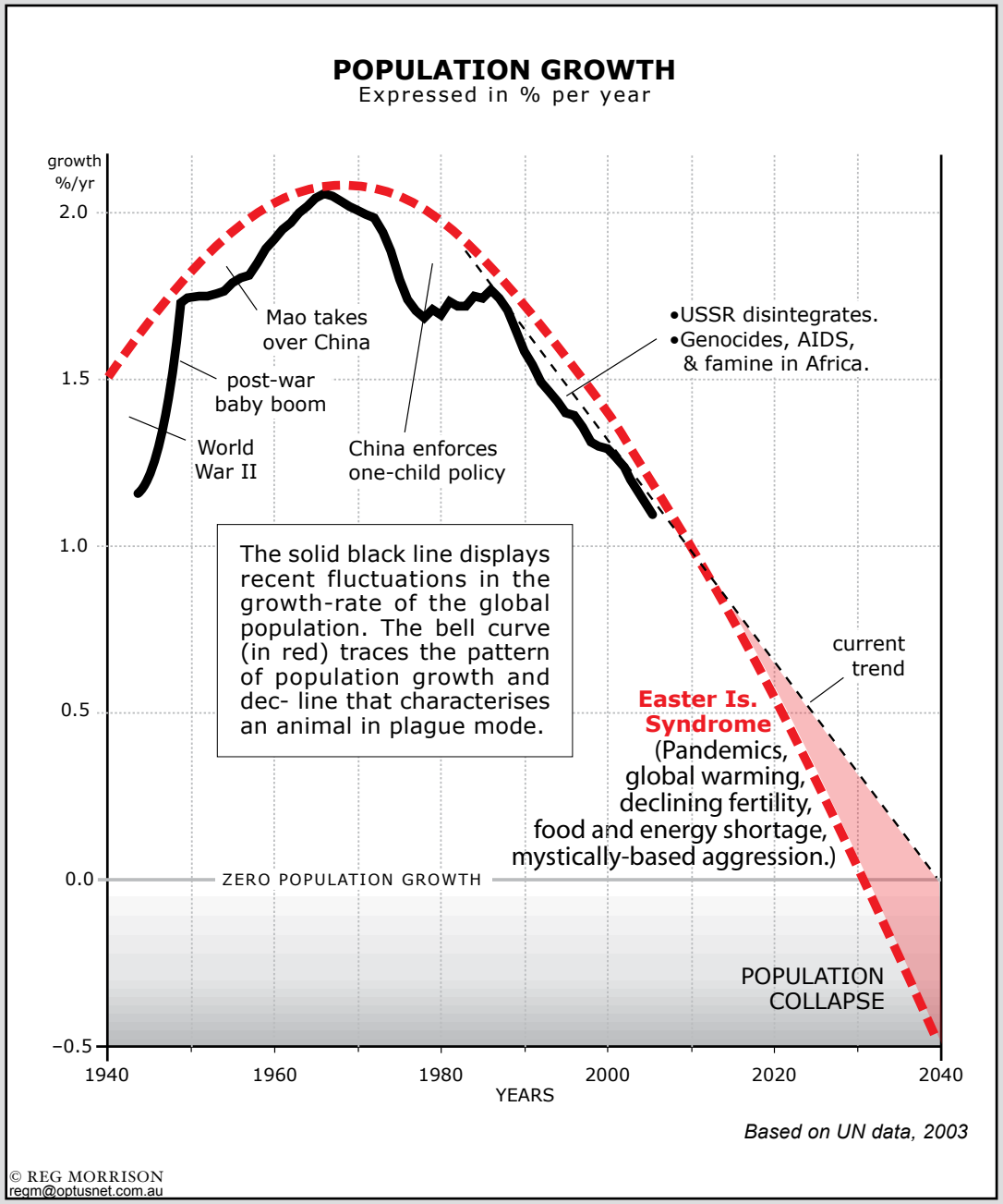






Since our species is a typical byproduct of genetic and Darwinian evolution this is the kind of graph we should expect to see. The explosive population growth that occurred during the past 200 years makes the label 'Plague Species' unavoidable.

* See NOTES 5 and 6. See also: APPENDIX 1 (GAS)



THE 'UNACCOUNTABLE' GRAPH

This graph is based on annual growth-rate figures that the UN's Population Division used to publish until 2003. Perturbed perhaps, by the abrupt decline that first appeared during the 1970s and then reappeared in the 1990s, UN demographers subsequently published only five-year 'forecasts' of global population growth.

The initial collapse in the growth rate that occurred between 1967 and 1978 was generally attributed to the introduction of China's 'One-child' policy. But when a similar decline reappeared in the 1990s the global nature of this phenomenon became impossible to ignore. It was often labelled an 'unaccountable demographic transition'.

Women around the world now tend to have half as many children as their mothers, and judging by current birth rates, this trend seems likely to continue. There has been no other global fecundity decline of this magnitude since civilization began, yet amid the clamour of cultural explanations, the biological and evolutionary significance of this global trend has been universally ignored.

NOTE: The basic shape of the black line shown in this graph was verified by UN demographers in 2004.

I added the bell curve and its Easter Island reference in red in order to provide a graphic reminder of the real (i.e. ***non-anthropocentric****) explanation for our species declining growth rate.* *

* See: **NOTE 7.** See also http://www.nytimes.com/2012/03/13/opinion/brooks-the-fertility-implosion.html?_r=1&emc=eta1&pagewanted=print

YEAR	POPULATION (in millions)		+ GROWTH (in millions)	= POPULATION (in millions)
2000	6056	1.30%	78.7	6134.7
2001	6134.7	1.26%	77.2	6212.0
2002	6212.0	1.22%	75.7	6287.8
2003	6287.8	1.18%	74.1	6362.0
2004	6362.0	1.14%	72.5	6434.5
2005	6434.5	1.10%	70.7	6505.3
2006	6505.3	1.06%	68.9	6574.2
2007	6574.2	1.02%	67.0	6641.3
2008	6641.3	0.98%	65.0	6706.4
2009	6706.4	0.94%	63.0	6769.4
2010	6769.4	0.90%	60.9	6830.3
2011	6830.3	0.86%	58.7	6889.1
2012	6889.1	0.82%	56.4	6945.6
2013	6945.6	0.78%	54.1	6999.7
2014	6999.7	0.74%	51.7	7051.5
2015	7051.5	0.70%	49.3	7100.9
2016	7100.9	0.66%	46.8	7147.8
2017	7147.8	0.62%	44.3	7192.1
2018	7192.1	0.58%	41.7	7170.8
2019	7170.8	0.54%	38.7	7209.5
2020	7209.5	0.50%	36.0	7245.6
2021	7245.6	0.45%	32.6	7278.2
2022	7278.2	0.40%	29.1	7307.3
2023	7307.3	0.35%	25.5	7332.9
2024	7332.9	0.30%	21.9	7354.9
2025	7354.9	0.25%	18.3	7373.2
2026	7373.2	0.20%	14.7	7388.0
2027	7388.0	0.15%	11.0	7399.1
2028	7399.1	0.10%	7.39	7406.5
2029	7406.5	0.05%	3.70	7410.2
2030	7410.2	0.00%	0.00	7410.2

Our ‘Unaccountable’ Decline

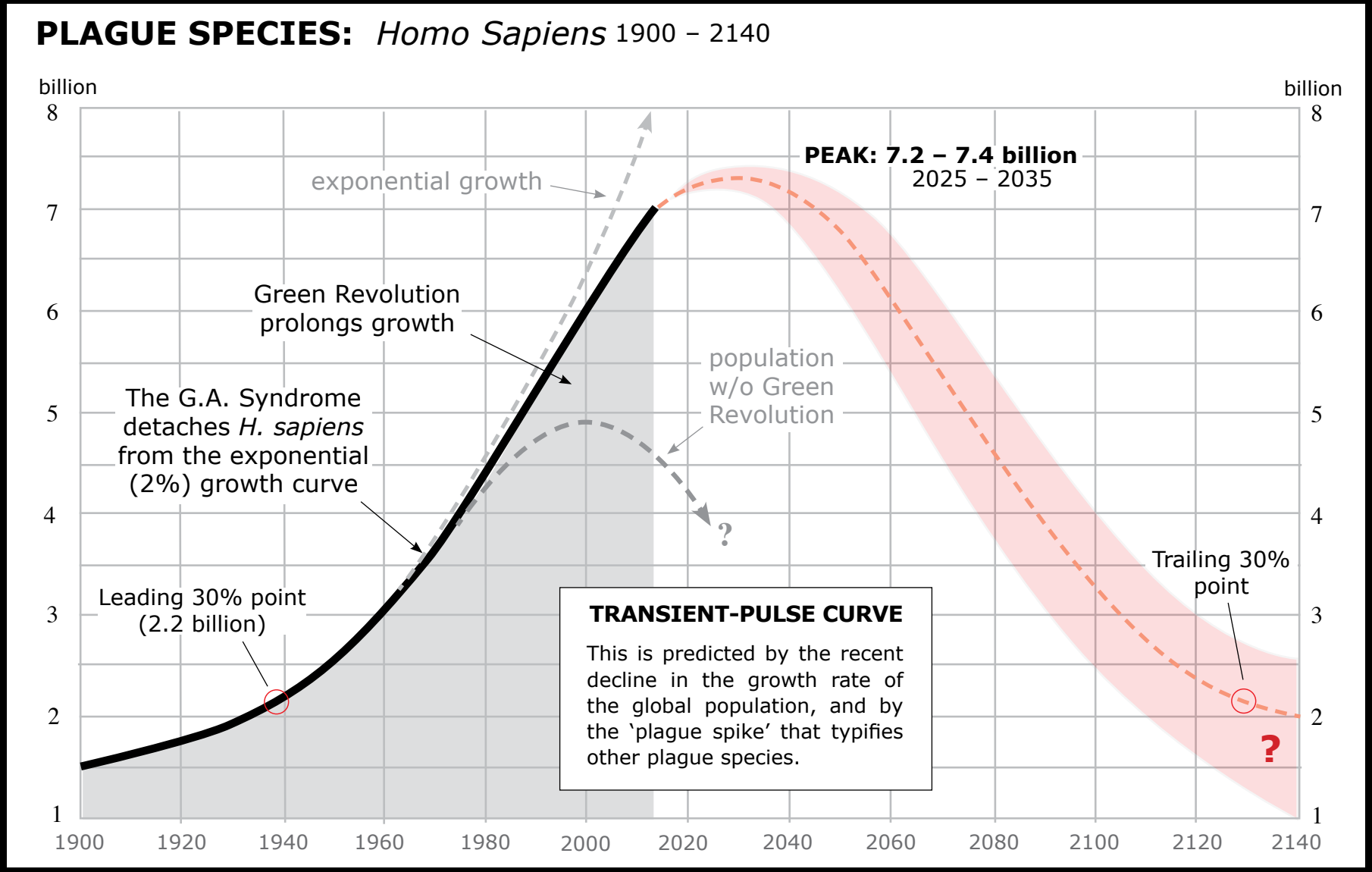
These are the approximate population figures indicated by the ‘Unaccountable graph’ shown on the previous page.

The annual decline in the yearly growth rate promises to achieve zero population growth (our population peak) about the year 2030. Our global population will collapse at an accelerating rate from that point onward.

Inevitably, all these figures are approximations, and they are bound to vary up or down by a small percentage due to the impact of cultural and environmental factors. For example, our population peak may well appear up to five years earlier than 2030 due to an increasing frequency and savagery of droughts, floods, starvation and pandemic disease. Meanwhile, acts of aggression triggered by regional shortages of food, fuels and other essential resources will add to the rate of population collapse.

So severe is this fecundity decline that more than 44% of the world’s people are now failing to replace themselves, and this pattern is not confined to just a few Western nations, nor even to the developed world. Since the 1970s fertility rates have dramatically declined throughout the Middle East, notably in Morocco, Syria and Saudi Arabia, where fertility declines of 60% have appeared. Meanwhile the highest rate of regional fertility decline (70%) was recorded in Iran.

This bizarre reproductive phenomenon bears all the hallmarks of Selye’s General Adaptation Syndrome.



In view of the current collapse in the fecundity of our global population (see previous page), this appears to be the potential shape of our species' plague to the year 2140.

*See "Life's Maker and Breaker"

EVOLUTION'S FAUSTIAN BARGAIN *

By 1960 our global population had reached three billion and was growing exponentially at 2% a year. This rate of growth was consistently outrunning the growth in agriculture, and as Malthus had warned, global starvation loomed ahead, possibly as early as the mid 1970s.

But science and technology came to the rescue—or so it seemed at the time. The development of high-yield crop species and a liberal application of petroleum-based fertilizers tripled the global harvest between 1960 and 2000. This not only averted a global food crisis, it boosted harvests to the point where human reproduction could safely go into top gear. As a consequence, the global population doubled in just 35 years. Science, technology and human ingenuity appeared to have saved us once again.

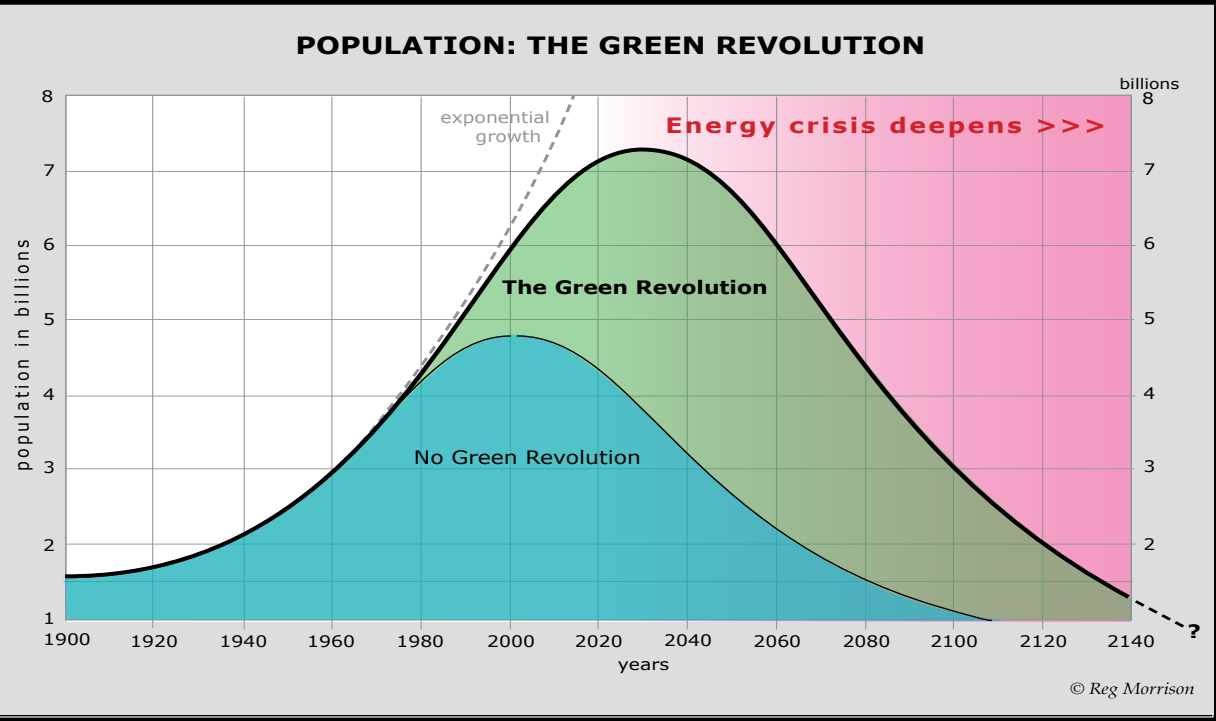
But cosmic laws determine that energy can neither be created nor destroyed, so 'high yield' is just a euphemism for 'high cost'. Inevitably then, the high per-capita harvests of the 1980s gradually disappeared in the 1990s as soil fertility shrank, fertilizer responses declined, and the population continued to explode. Our species has now returned to the evolutionary precipice on which it stood in 1965 … but with two crucial exceptions. We are now wholly dependent on oil for motor fuel, lubricants and fertilizer, and twice as many people now face the spectre of starvation as global oil supplies begin to shrink. Hydrogen, the generator of life, is about to become its breaker once again.

When pandemic disease, Selye's GAS, and the backlash of a bruised environment begin to fulfil their standard anti-plague roles we will face collapse once more, but having overshot Earth's carrying capacity and drained our cheap energy sources, this time there will be no escape.

Technology's hidden face

*This graph reveals the Faustian face of human technology. All of the advantages it appears to offer are invariably outweighed by its hidden costs. Technology takes its 'pound of flesh' in the form of energy loss at some other place or at some later time, or via what is known as Jevon's Paradox.**

It means that technology is never the panacea that it seems, and given time, it inevitably incurs a disproportionate cost. These are the inviolable rules of existence in a thermodynamic universe that is entropic (running down).

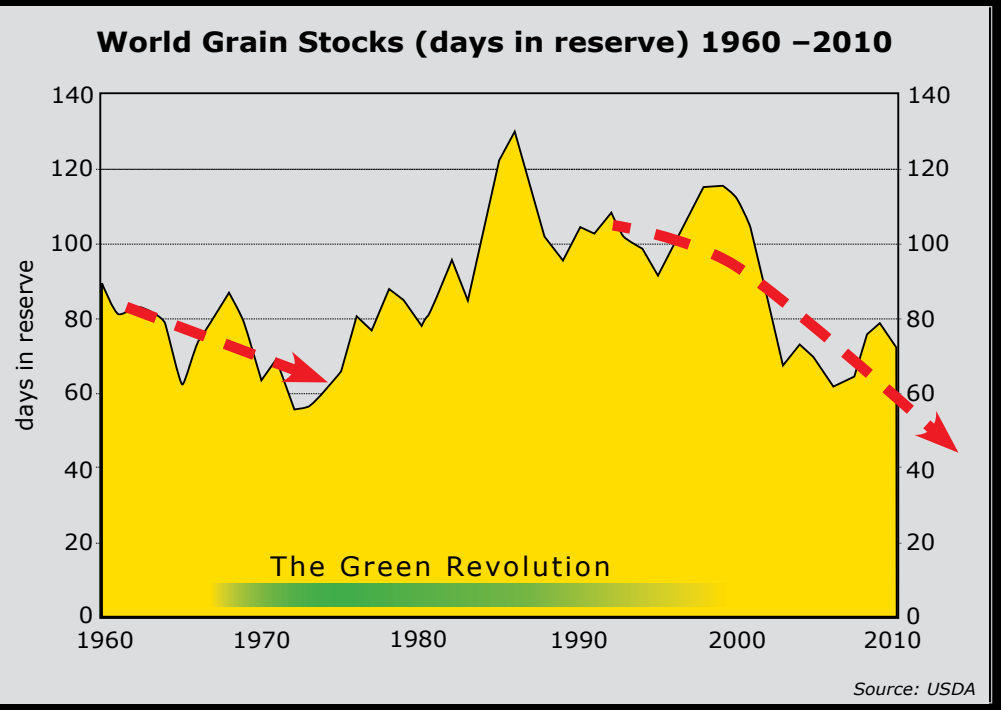


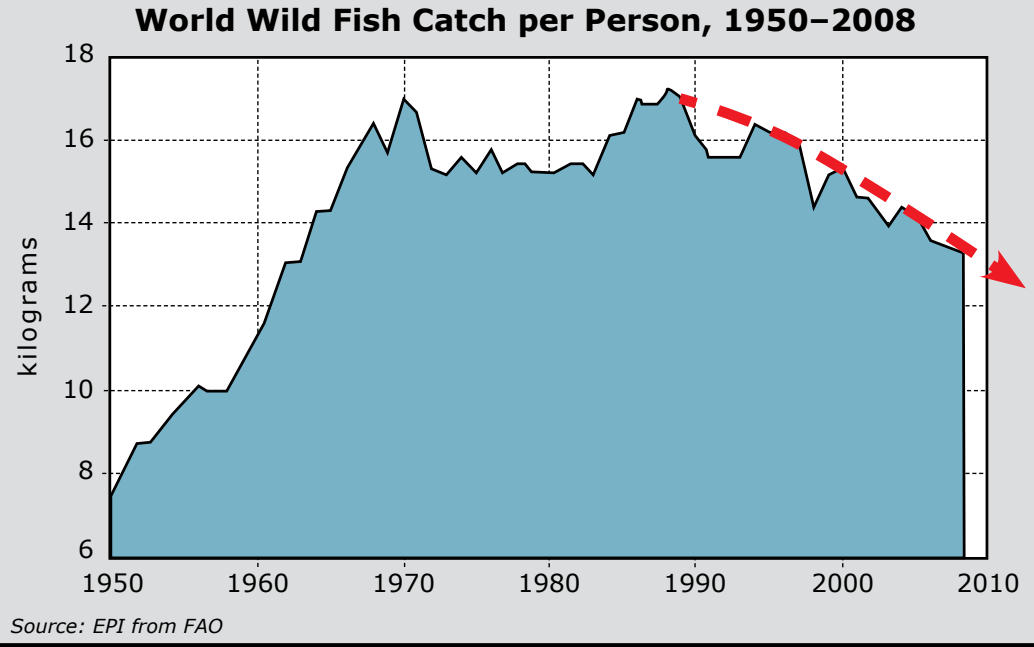
* See APPENDIX 2 and NOTE 8

Evolution's Lethal Fee

We are now on the brink of a food crisis of even greater magnitude than the one that threatened our species in the late 1960s. We avoided a population catastrophe on that occasion by the arrival of the so called 'Green Revolution'. The combination of high-yield crops, mechanised monoculture, large-scale irrigation and the addition of nitrogen-rich, petroleum-based fertilisers tripled the global food harvest. But by prolonging the post-war population boom for a further 40 years it seems to have sealed our species' fate.

We are now about to feel the full weight of the savage penalty clause that is embedded in the fabric of the evolutionary process. Excessive energy extraction has a lethal fee attached.





'Thanks for all the fish ...'

The current decline in the annual marine harvest—essentially due to rapacious commercial fishing—has helped to push our species to the brink of a Malthusian catastrophe.

Many marine biologists now warn that a third of all major fisheries have either collapsed or are in terminal decline. Stocks of every species of large wild fish have shrunk by 90% or more in the past 50 years, and the survivors are generally between one fifth and one half the size of the adults that were caught 50 years ago. This means that about 30% of the seafood stocks available in 1950 have now collapsed.

THE ENERGY GAP

Since we live in a thermodynamic cosmos that is entropic (running down), the process of energy extraction is inherently uneconomical. In other words, the production, distribution and application of energy takes more energy than the extraction process can produce.

There are three notable exceptions to this rule: coal, oil and natural gas. These fuels are economical because the planet has already done most of the preliminary processing by collecting their organic raw materials into reservoirs and then partly refined them by applying massive heat and pressure over millions of years. This also makes these hydrocarbon energy carriers cheap to extract and easy to use.

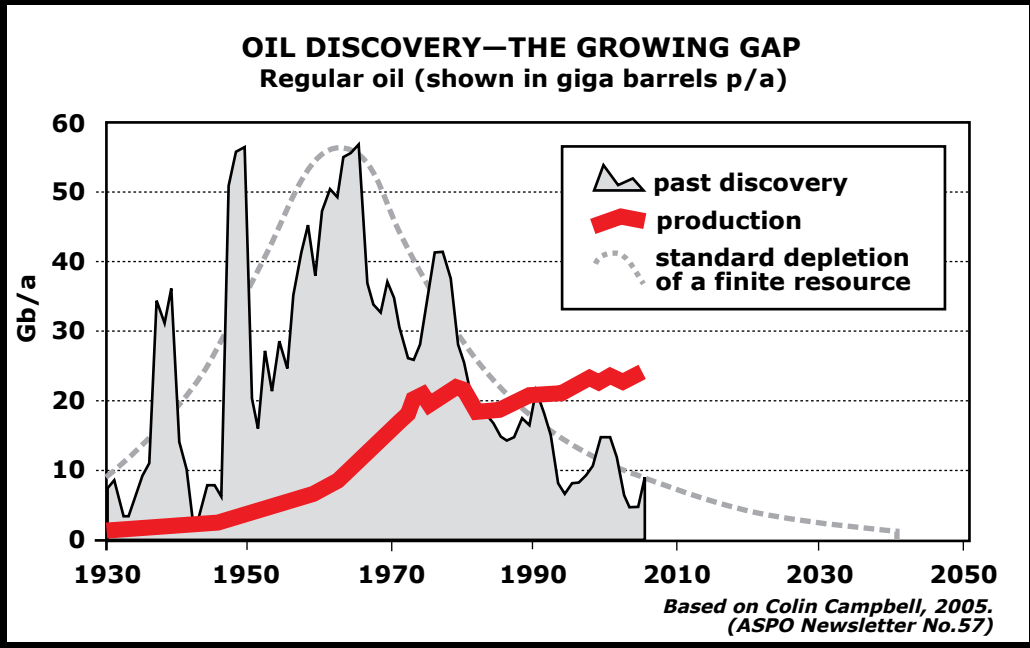
The more hydrogen a fuel contains, the more energy it yields. The fossil fuel with the highest energy-yield is oil, and being fluid, it is also the most easily transported and burned.

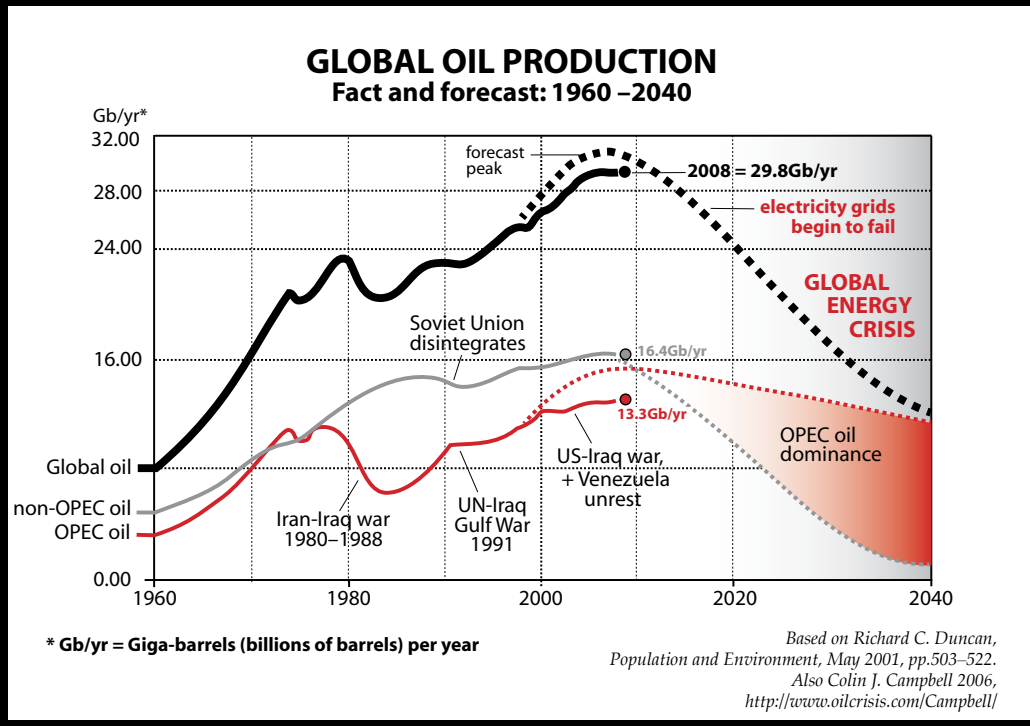
Modern civilisation pivots on this finite resource not just because it fuels combustion engines, but because it enables the production of electricity, and electricity powers the three functions that fuel and lubricate the gears of all modern government and commerce: Communication, Computation and Control—the C3 functions.

Very few people are aware, however, that on a per-capita basis, oil-based energy production peaked in 1979 and has been declining ever since. This decline is still accelerating due to the explosive growth of the human population, the decline of old oilfields, and a dearth of new oil discoveries.

The gap between per-capita energy demand and supply is now critical. About 85% of the energy presently consumed by industrial nations provides heat, light, and mechanical motion, and the other 15% powers the C3 functions. Meanwhile, some 42% of the world's primary energy goes into generating electricity, the indispensable end-use energy carrier of our time.*

Oil production plateaued in 2005 and has remained stable since then. When supplies begin to decline during the next decade civilisation's lights will begin to flicker out and social disorder will become global.





MYSTICISM

Our timebomb is mysticism. Its delivery system is language. And its hiding place? The unfathomable coils of our DNA.

(*The Spirit in the Gene*, 1999)

By selectively preserving the mystics among our hominid ancestors evolution not only gave us the weapon that would catapult us from obsolescence to world domination, it also took out a shrewd insurance against our species' overwhelming reproductive success.*

Only such a deliciously rewarding and tamper-proof device as mysticism could have prevented us from foreseeing the danger of overpopulation a long, long time ago. And the corrosive mental derangements born of religious and political mystical beliefs will easily derail our global efforts to cooperate and survive our population peak—just as they did on Easter Island more than three centuries ago.

By this means, the Gaian processes of automatic plague-collapse will ensure that fanatics of all kinds, both religious and political, will feed and inflate humanity's growing fears during the next two stress-filled decades. This will ensure that distrust and hatred between nations, races, and religious and political groups reaches a crescendo as the environment begins its savage counter-offensive against the current plague of *Homo sapiens*, the biosphere's primary destabiliser.

Looked at in this light the multitude of bonding mechanisms that bind us into semi-tribal groups both large and small now seems certain to midwife our species' collapse.

RIGHT: Torture and genocide have been the milestones of mysticism throughout history ... the Crusades, the Inquisition, the Holocaust, Ruanda, Pol Pot's Killing Fields, and a million other nameless obscenities.

* See also: "***Evolution's Gamblers***"

THE PEACOCK EFFECT

Evolution's great strength lies in the fact that even the most efficient and fecund species are available for culling. This universal vulnerability hinges on what might be called the Peacock Effect. In peacock society the male's spectacular tail is a major reproductive asset, but only in the species' birthplace—a forest. Should the forest disappear, the peacock's cumbersome tail instantly doubles as a gaudy advertisement for fast food in the eyes of any passing predator.

All species possesses adaptive specialisations that have enabled them to survive and reproduce within the habitat that nurtured their specialisation. But change the environment, and such specialisations become handicaps—the more extreme the specialisation, the more lethal the handicap. In other words, each species has its own personal peacock tail, even that 'paragon of animals', *Homo sapiens*.

In an evolutionary sense our peacock tail is just as spectacular as the bird's, although you wouldn't know it to look at us since it is entirely intangible and very well concealed, residing as it does in the three billion base pairs of our DNA. It is an emergent behavior, produced, it seems, by a host of genes that interact according to environmental circumstances.

Our peacock tail is our inherently mystical nature. It is expressed in our peculiar capacity to believe implicitly in the patently unbelievable, and to attribute unnatural power or mystical significance to anything that either contributes to, or threatens, our genetic survival—thereby revealing its true origin. Mysticism's universality and its umbilical links to DNA's primal imperatives, 'survive and reproduce', clearly identify it as a genetic artefact.

Whether our mysticism relies on a belief in supernatural forces such as gods, angels, witchcraft, astrology and intergalactic aliens, or whether we believe in luck, tea leaves, memes or market forces, the precise nature of the belief is of little consequence to our genes. The only thing that matters to them is the quality and strength of the tribal passion that those beliefs generate. Darwinian selection does the rest. Two million years of hunter-gatherer hardship has honed human mysticism into a weapon of unparalleled power—an evolutionary Excalibur …

The ‘Rational’ Delusion

Reproduction is the pivotal feature of all biological existence, and the complex machinery that drives our sexual urges and regulates our daily behaviour is embedded throughout our DNA. It ensures that this crucial machinery lies beyond the reach of our new and incompetent rational cortex.

Our genes insert their directives into human behaviour under the cloak of morality and culture, and reinforce those directives by powerful tides of emotion. This ensures that our genes are not handicapped by ‘rational behaviour’ when speedy genetic responses are required for genetic survival.

That is why, under the spell of our genetically programmed ‘spirituality’, we cannot help falling in love, seeking sexual gratification, nurturing our children, forging tribal bonds, worshipping our gods, suspecting strangers, uniting against common enemies, and on occasions, laying down our lives for family, friends or tribe. The gaudy tides of emotion that protect and reinforce these patterns of behaviour ensure that we remain entirely unaware that these behaviours are genetically directed. In a metaphorical sense, no gene could ask for more.

Such crucially important genetic machinery has been carefully shaped by rigid Darwinian selection during the past five million years and it brooks no ‘intellectual’ inteference. Masked by an impenetrable smokescreen of morality and culture, our DNA is now able to provide a highly flexible ‘volume-control’ for our fecundity, a control that responds quickly to environmental cues, and whose genetic origins remain concealed from us ... *

EMOTION: The Battle-Cry of Genes in Action

The appearance of emotion signals that our genes have been stung into action by some external threat, explicit or implied. From that moment on, any other judgements made by our rational cortex may be overridden or remoulded in favour of ancient genetic behaviour that has survived in human genomes for a million years or more. The switching device is known as the "Suspension of Disbelief". *

The only real problem arises when there is a major discord between behaviour that might help an individual's to survive and reproduce, and behaviour that contributes to the tribe's survival. Such discords lie at the very core of the 'hero's dilemma', and in varying degrees, they represent the genetic foundation of all human 'morality'.

Looked at in this light, all culture is blatantly genetic. It is preserved by emotions that disengage rational thought whenever our genes perceive the slightest threat—to themselves or to their alleles.[1]

This allelic imperative is typically reinforced by various social carrots and sticks designed to lock our behaviour into patterns that preserve our alleles in other members of the 'tribe'.

Since genes tend to replicate, cooperate, and survive in groups, and since alleles therefore tend to cooperate and replicate in similar groups, this helps to explain some of the powerful allegiances that form between 'like-minded' people, whether directly related or not.

It explains the strong loyalty bonds that often exist within social, commercial and political sub-groups, steering them towards behaviours that seems appropriate to them at the time.

Hence our predisposition to adopt mystically driven tribal behaviour of all kinds, and hence our ready resort to fight or flee . . .

The 'Spirit' is in the Gene

"Although our species' conquest of the planet might appear to represent the gradual triumph of the intellect over our brutish nature, in fact, precisely the reverse is true. Being primarily founded on, and driven by, mystical beliefs of one kind or another, human civilisation represents not so much a triumph of the mind over the body as the triumph of the gene over gene-threatening rational thought."

'The Spirit in the Gene' / 'Plague Species'

* See next page

1 An allele is a corresponding gene (not necessarily identical) that occurs in related individuals.

‘Suspension Of Disbelief’: Birthplace of Daydreams and Nightmares

There is an intriguing mental device that our genes use whenever they want to squeeze our perceptions into a shape that better suits their purpose. This curious neuronal phenomenon is commonly known in theatrical circles as the ‘suspension of disbelief’. The term refers to the brain’s ability to switch out reality and replace it with a fictional scenario that rhymes with our genetic imperatives.

Like the ‘hot-wire’ that a car thief uses to fire up the motor when he has no key, the ancient hotwire that links our senses directly to our genes allows us to by-pass our inexperienced and error-prone rational cortex the moment our genes perceive the slightest threat, either to them or to their alleles. It gives us instant access to violent behavioural responses, such as ‘fight’ and ‘flight’, that have helped to preserve human genomes for the past two million years.

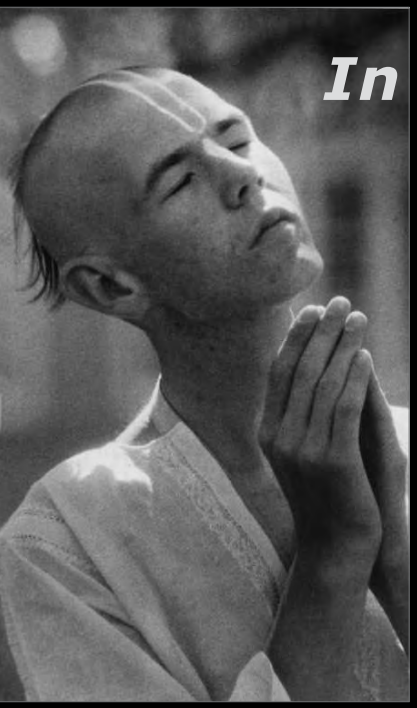
This ancient genetic hotwire has an astonishingly wide variety of every-day uses. The world of entertainment utterly depends on ‘suspension of disbelief’ to seduce the viewer into switching off rational thought and believing instead in the fictitious characters and events being portrayed on the stage or screen before them.

This ancient neuronal short-circuit switches on the moment a fictional character or event touches one of the multitude of mental buttons that are linked to our basic genetic imperatives to survive and reproduce. Touch one of those buttons and a stew of hormones and neurotransmitters flood the body and brain, generating a rush of emotion that switches out the neuronal cortex, and brings rational assessment to a halt. The imagination fires up, transforming fantasy into ‘reality’, and in that extraordinary instant almost anything becomes mentally possible. In that bizarre moment even the most trivial event may be transformed into something ‘divine’.

Here is our genes’ secret weapon in their age-old struggle to survive and reproduce in a hazardous and unstable environment. Here is the shrewd old genetic midwife that delivers passionate belief in the patently ridiculous—in witchcraft and spells, in gods, miracles, angels and devils; in the validity of religious dogma and astrological predictions; in sustainable development, in ‘market forces’, in alien abductions and perpetual economic growth.

In essence then, here is the device that bestows peculiar mystical significance on ‘the home team’, ‘the political party’, ‘the Church’, and ‘the Flag’, thereby bonding us into families, tribes, nations, religions and ethnic groups; into teenage and criminal gangs, and into political parties and their childish factions. And it was this same dream-making facility that allowed 19 al Qa’eda terrorists to see only heroic martyrdom in their suicidal attacks on New York and Washington on the 11th of September, 2001.

As our social stress levels grow, so will the level of emotion throughout society. And in consequence, our ability to censor reality will grow stronger, nurturing more nightmares in the form of religious, ethnic and political extremism. In this fashion our genes will keep us largely oblivious to the threat of extinction that faces our species as it slides headlong into resource depletion, climate change and population collapse. Our ancient ability to switch off rational thought and believe genetically sanctioned ‘visions’ will nurture even more tribal extremism—religious, political and pathological.



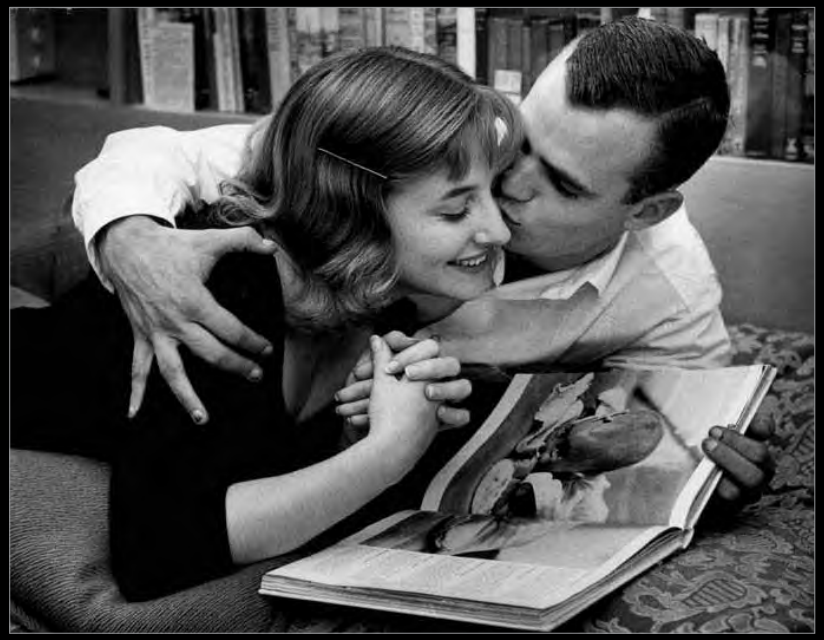
In times of stress ...

... the genes assume control ...

... and reason disappears.

See also: **APPENDIX 3** ('Nature v Nurture')

ALL BEHAVIOUR IS GENETIC



This is the molecular reality that binds all life together.

SUMMARY

ENERGY: LIFE'S MAKER AND BREAKER

- As a component of our thermodynamic universe Earth's energy gradient is Chaotic, fractal and sensitive to any altered input; and as an interchangeable expression of the planet's crust its biota is a biological cog in the planet's energy-dissipation machinery.
- Each species' survival is therefore strictly determined by its energy budget. Species that extract too little or too much energy are swiftly eliminated. Inadequate energy extraction leads directly to energy starvation and population collapse. Conversely, excess energy extraction produces exponential reproduction—a 'plague' event—and this too, leads to energy starvation and population collapse.
- Our *Homo* genus evolved as a primate hunter-gatherer some 2.5 million years ago and survived well for most of that time, but threatened by the end of the Ice-Age 10,000 years ago our hard-pressed ancestors were forced to surrender their rich hunter-gatherer heritage in favour of a more stationary, unhealthy life, herding captive animals and cultivating food plants to augment their shrinking diet.
- Boosted eventually by the development of fossil-fuels, combustion engines, mechanised monoculture, irrigation, pesticides, petroleum-based fertilisers, and industrial fishing, food became abundant. Inevitably, our fecundity erupted, and we became a plague species.
- Our primary energy courier, electricity, now delivers civilisation's three essential ingredients: communication, computation and control. Most personal, cultural and commercial interaction is now electricity-dependent, meanwhile the looming decline of oil threatens to bring all this, and all the complex machinery that mediates our technoculture, to a gradual halt.
- The environmental consequences of our unbridled population growth and habitat destruction will meanwhile bring our food abundance to an end, and our innate mysticism will then reveal its darker side in tides of ignorance, social unrest and fear-fuelled aggression.
- In accordance with the laws of thermodynamics this decline is now unavoidable and will prune our species back to its genetic roots.

Last of Australia's desert nomads, Little Sandy Desert, WA (1963).

END

APPENDICES

Following pages:

APPENDIX 1 — General Adaptation Syndrome (4 pages)

APPENDIX 2 — Evolution’s Faust Clause (2 pages)

APPENDIX 3 — Nature v Nurture

NOTES

BOOK: ‘*The Spirit in the Gene*’ / ‘*Plague Species*’

Selye's GENERAL ADAPTATION SYNDROME (G.A.S.)*

Hans Hugo Bruno Selye, the Austrian-Hungarian endocrinologist who first identified and described the General Adaptation Syndrome, was born in Vienna in 1907 and died in Montreal, Canada, in 1982. His early research hinged on the fact that irruptive rodent populations always began to decline long before their food resources collapsed and starvation became widespread.

The 1936 paper in which Selye first described his research into the disastrous side-effects of population stress on various animals was entitled "A Syndrome Produced by Diverse Nocuous Agents" (*Nature* 138 no. 32.) He followed this with: "The General Adaptation Syndrome and Diseases of Adaptation." (*Journal of Clinical Endocrinology and Metabolism* 6, 1946)

Selye's original findings have since been echoed in varying degree by many other researchers, but perhaps most notably by John J. Christian, Vagn Flyger and David E. Davis in their paper entitled "Factors in the Mass Mortality of a Herd of Sika Deer *Cervus Nippon*," (*Chesapeake Science* 1, June 1960, pp.79-95).

The remarkable feature in the collapse of the Sika deer population on James Island, Maryland, was that they were well-nourished, safe from predators, and parasite free at the time. However their growth was also found to have been significantly inhibited. This inhibition was shown by autopsy to have been induced by behavioral stress associated with high population density.

Selye eventually founded the International Institute of Stress in Montreal in 1977, and his subsequent research into human stress showed how population pressure released a similar suite of hormones to those seen in other mammals. Selye found that these could lead to many of the disorders that were characteristic of human society in the twentieth century. . . .

* See **NOTE 1**

The G.A.S. in human society

Our GAS decline appears to have begun in the late 1960s and already our species displays most of the symptoms that typify Selye's syndrome. Significantly, many of our recent fertility inhibitors are associated with either a surfeit or dearth of hydrogen.

Our reproductive decline commonly correlates with blood levels of steroids. Steroids consist of four linked carbon rings that carry more than 50 hydrogen atoms. The sex hormones oestrogen, testosterone, progesterone, and their derivatives are all steroids. This makes them strongly hydrophobic and peculiarly able to slip through the waterproof bi-lipid membrane that forms the walls of eukaryote cells and the plasma membrane that encloses the nucleus. Once inside the cell such steroids bind to DNA transcription factors, changing their shape and altering their gene-transcription capability.

A related adrenal steroid, cortisol, is also known to play a direct role in fertility regulation. Not only is it a by-product of stress that prepares the body for 'fight or flight', it seems peculiarly able to interfere directly with the expression of genes that orchestrate development of the reproductive organs and the reproductive process. This direct hormonal link between stress and reproductive malfunction, both male and female, represents a significant evolutionary asset in that it tends to curb wasteful overpopulation when social and environmental circumstances are not supportive.

It now seems likely that some of this behaviour modification may be produced epigenetically via changes in the methylation pattern of DNA.

The process of sexual maturation is largely governed by hormones secreted by the adrenal glands and by the hypothalamus-pituitary-gonad (HPG) axis. As these sources mature in a young girl they release increasing amounts of sex hormones into her body, triggering a cascade of physiological processes associated with sexual maturation. These include increased fat deposition around the hips and thighs, the growth of breasts and pubic hair, a broadening of the pelvic girdle, a widening of the birth canal, the onset of menstruation (menarche), and finally, ovulation—the production and release of an egg. . . .

G.A.S. — Early Menarche etc.

During the past 150 years the age of menarche has fallen from 17 years to roughly 12.5 years in the UK and Norway, and a recent study of 2,510 girls in the US found that their median age at menarche was now only 12.43yrs and still falling. This massive acceleration of menarche appears to be common in industrialised nations and it is hard to avoid the conclusion that it represents an accumulated threat response to the growth of crowded urban populations, the erosion of family ties, and an increasing sense of social insecurity. But this new reproductive regime has revealed another, more disturbing ramification. For girls aged 13 or more the average time from menarche to 50% ovulation (when 50% of the reproductive cycles produce viable eggs) is about 4.5 years. For an 11-year-old, however, the delay between menarche and 50% ovulation is drastically reduced—to about a year in most cases.

The presence of natural parents and other closely related genomes in a girl's extended family tends to retard menarche and ovulation until the girl is mature enough to nurture a new generation with minimal assistance from outside. But girls have also been programmed (by at least two million years of evolutionary experience) to switch into reproductive readiness somewhat earlier should the extended family environment be threatened or disrupted. It now appears that the adrenal threat-hormone, cortisol, is implicated in triggering this response.

As indicated in Appendix 1, some environmentally induced changes in the methylation pattern have been shown to persist for many generations in some mammal species. For example, when the standard pattern of methylation within the two sex chromosomes, X and Y, becomes altered, or when one of the female's two X chromosomes fails to switch off, the sexuality of the offspring may become blurred and they may exhibit a wide range of dysfunctional behaviours and structures. As in rodent populations, in humans these dysfunctions include genetically unproductive forms of sexuality, malformed genitalia, lowered sperm counts, and a rising incidence of testicular, ovarian and other cancers.

Hormone disruption traceable to the break-down by-products of paints, plastics, industrial solvents, insecticides, herbicides, fungicides and defoliants and many other industrial chemical have been shown to have precisely these effects on many vertebrates, even at relatively low levels of exposure. . . .

G.A.S. — Fecundity Decline

Hydrogen-loaded residues from contraceptive pills and other pharmaceuticals contribute significantly to the general fertility decline. In addition, the growing number of IVF births and caesarian deliveries enable the foetus to sidesteps intra-uterine selection and immunization processes, thereby ensuring that it passes on a much higher percentage of genetic defects and immune-system dysfunctions than do normal births. Similarly, the adoption of androgynous clothing and hairstyles, and the drift away from 'blood-flush' colours in women's cosmetics sends the clearest possible signal that the primary imperative of life, to reproduce, has been significantly reduced in many fertile young women.

There is also evidence to suggest that the global increase in eating disorders, in obesity, in clinical depression, and in suicide among the young are explicit symptoms of Selye's pervasive syndrome in that all directly target human fecundity. Less obvious symptoms are the consumption of anti-depression pills, 'recreational' drugs, and muscle-building steroids to reassure the more stressed and insecure among the young. These too, reduce fertility, especially in men. And as pollution levels continue to rise around the globe, sperm counts and sperm motility also continue to decline. This pattern is especially true of industrialised Western nations during the past three decades. In Australia, for example, sperm counts have fallen by almost 30% since 1989, and similar falls have been recorded in Britain, the US and several European nations.

The low level of infant mortality and the apparent absence of cannibalism might represent reassuring anti-GAS factors were it not for the fact that both are indeed present and growing fast on a global scale—although both are very well concealed. The widespread practice of pregnancy termination by various physical, chemical and medical means, plus the development of national (and international) blood-transfusion and organ-transplant services, constitute rampant infanticide and cannibalism in a medically sanitised and culturally palatable form. The trade in blood and body parts is now common everywhere and is booming in the world's more impoverished, overpopulated regions, notably China and India. Although it might seem grossly offensive to describe such widely admired medical procedures as cannibalistic, the transplanting of fluids, flesh or organs from one human body into another precisely fulfills the essence and intent of cannibalism, regardless of the circumstances.

It seems that Selye's General Adaptation Syndrome is running like a Swiss watch. ❇

'FAUSTIAN BARGAIN':

This reference to the 'Faust' legend offers a literary analogy for the ultimate energy debt that a species incurs when it increases its energy uptake via evolutionary specialisation. In other words any adaptive specialisation involves a loss of evolutionary lifespan.

• As an interchangeable extension of the Earth's crust life itself is part of the planet's energy-dispersal machinery. In this sense, each organism is an energy-shedding device that helps to dissipate energy from the body of the planet and redistribute that energy throughout the biosphere until it leaks away into space.

• Evolution is the process by which organisms acquire complexity in order to gain access to energy sources that lie beyond the reach of their simpler competitors. In this way, greater organic complexity demands greater energy consumption and leads to a higher energy debt that eventually becomes lethal. In other words, any innovative increase in a species' rate of energy extraction invariably entails an evolutionary disadvantage of greater significance, usually by making the species more vulnerable to extinction when the environment changes.

• In human society the same Faustian factor emerges in the form of **Jevon's Paradox** in which any energy savings gained by improved technology invariably leads to greater consumption due to increased uptake of that technology. The steam engine and the combustion engine are eloquent illustrations of this. Similarly, improved energy extraction, 'renewable' or otherwise, leads to greater consumption, greater environmental damage and an ever-increasing deformity of the planet's system of energy-dissipation. ❇

*In its best-known literary sense the word 'Faustian' refers to a play entitled "The Tragical History of Dr Faustus" by the 16th century English playright Christopher Marlowe. Like the Germanic Christian fable on which it was based, the play describes the downfall of an erudite but bored scholar who sells his soul to the Devil in exchange for immediate worldly knowledge and unlimited physical and mental pleasure.

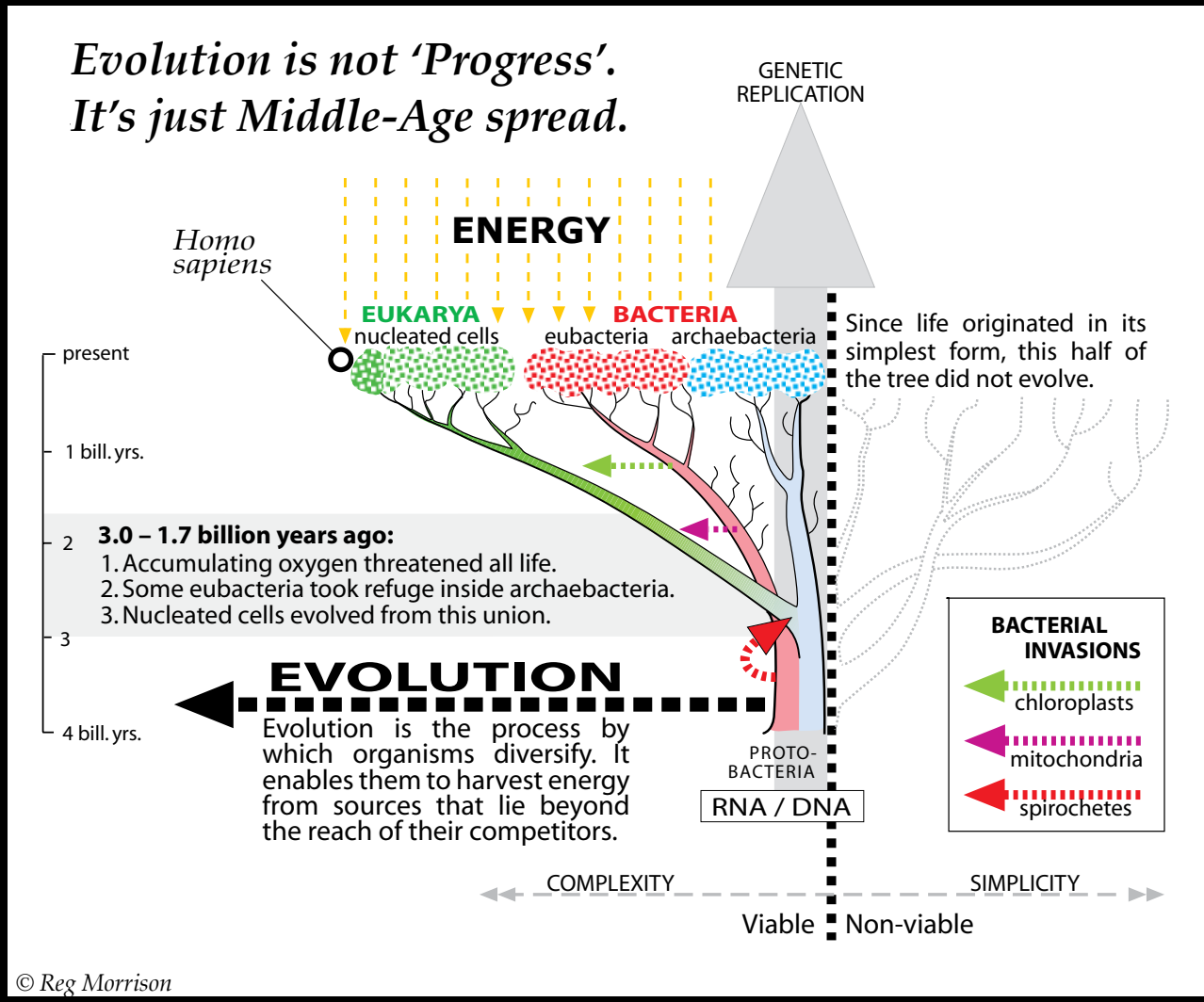
LIFE'S FAUSTIAN BARGAIN

All evolutionary specialisation represents a trade-off in which long-term survival is exchanged for a short-term energy gain.* For example, when some eukaryote cells acquired large numbers of mitochondria and developed a respiratory system based on oxygen, they gained energy as well as some additional protection from oxygen, but this change entailed a savage long-term penalty.

Since these respiration-based cells lacked cyano-bacteria and were therefore unable to harvest enough hydrogen to run their complex, energy-expensive metabolism, they now had to acquire it second hand—either by eating vegetation themselves or by eating the plant-eaters.

The additional energy gained from an oxygen-fuelled metabolism thereby enabled animals to power movement and maintain an even body temperature, but as predators, scavengers and grazers their survival ultimately depended on an abundant supply of vegetation. And this essential dependency made them far more vulnerable to extinction whenever the climate changed and their regional vegetation declined.

In this fashion humanity's ultimate dependency on vegetation has threatened our survival in the past, and as global climate change accelerates, it threatens our species once again.



EVOLUTION'S PENALTY CLAUSE

The savage evolutionary penalty that animals invoked by their switch to energy parasitism exemplifies the Faustian nature of evolution in general, and of energy extraction in particular. Our species is now about to face the evolutionary consequence of our massive energy consumption.

'NATURE v NURTURE'

The effect of 'nurture' that is so often seen as overriding our inate (genetic) nature, is itself, entirely genetic. It arises from the extraordinary range of genetically orchestrated responses that are available to outsize, overgrown brains like ours when they are presented with obstacles that threaten our physical survival or the survival of our genetic line via offspring or relatives.

Certain environmental pollutants are now known to affect our methylation patterns, as do episodes of extreme stress, especially in childhood. Even a lack of appropriate parental nurturing during our developmental years has been shown to alter our methylation patterns.[1] The simple process of ageing also appears to slightly rearrange the epigenetic tags on our DNA.

Most of these methylation changes may be relatively small but by altering our perceptions of the world around us and our memories of it, they can thereby remould our adult behaviour to varying degrees.

SHORT-TERM MEMORY: This mammalian characteristic appears to be based on epigenetic changes in the DNA of neurons in the human hippocampus in response to environmental stimuli. The resulting methylation pattern and its associated memory tends to disintegrate in a few days.

LONG-TERM MEMORY: This appears to be a cortical 'echo' of the short-lived hippocampal changes, but these changes are much more permanent and become semi 'fossilised' in the methylation patterns of cortical DNA.[2]

The human cortex has doubled its volume and quadrupled its surface area during the past three million years and is now able to archive a large number of these minor changes. This archive constitutes a very useful form of long-term memory—fragmentary, error-prone and malleable though it is.

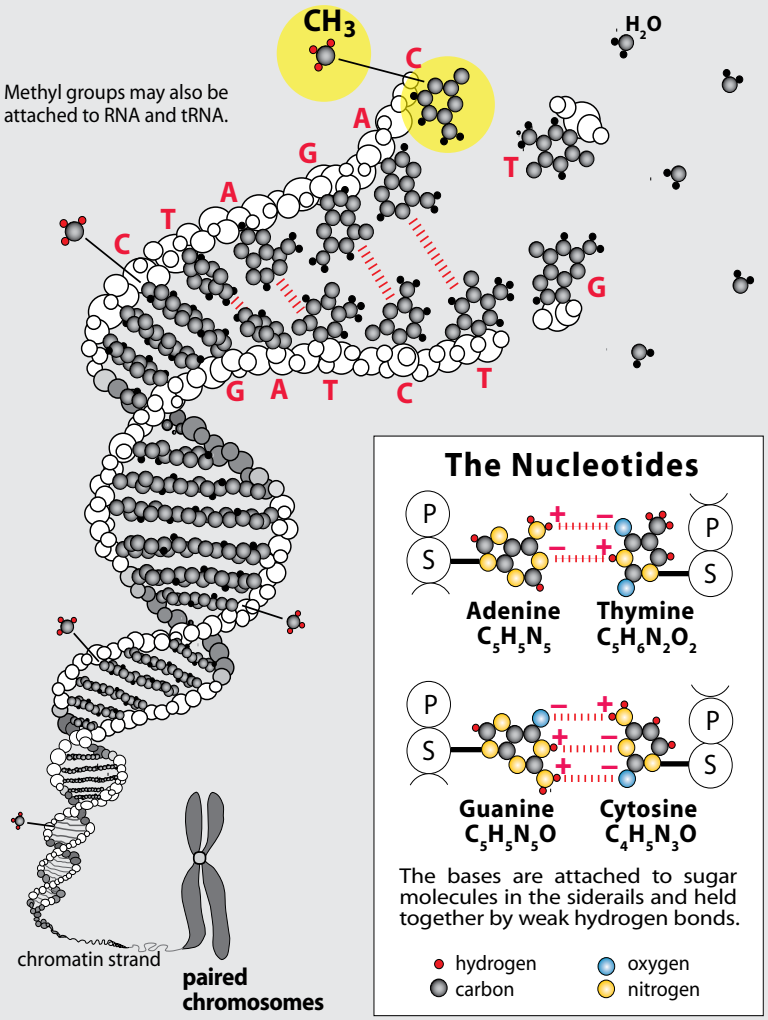
Consequently, methylation plays a major role in manipulating our perceptions of the world around us and plays a crucial role in shaping our day-to-day behaviour. All behaviour is genetic in origin. No other driver exists.

1 Ian Weaver, Moshe Szyf and Michael Meaney, "Maternal care effects on the hippocampal transcriptome and anxiety-mediated behaviors in the offspring that are reversible in adulthood". *Nature Neuroscience* vol.7 p.847, 2004 (Proceedings, National Academy of Sciences.) **2** Courtney Miller and David Sweatt. "Covalent Modification of DNA Regulates Memory Formation", *Neuron*, Volume 53, Issue 6, pp.857-869, 15 March 2007.

DNA Methylation

Methyl tags (CH_3) are most commonly attached to cytosine, but occasionally to adenine and other sites, including the histone'bollards' about which the strands of chromatin are wrapped.

Adenine (A) (T) Thymine
Guanine (G) (C) Cytosine
hydrogen bond



The Nucleotides

The bases are attached to sugar molecules in the siderails and held together by weak hydrogen bonds.

By regulating the folding pattern of DNA's chromatin strands its methyl tags determine which genes can be transcribed and which are 'switched off'. DNA's epigenetic code thereby constitutes a highly flexible gene-management system that is sensitive to external and internal interference initiated by environmental factors.

Reg Morrison, 2009

See also: ***'The Enigma Code'***

NOTES

Many of the topics touched upon in this text are covered in more detail in "***Life's Maker and Breaker***" which can be found on my website at: http://regmorrison.edublogs.org/

[1] The colours that drift across a **soap film** as it thins to bursting point are produced by wave interference between light rays that are reflected from the front surface of the film and those reflected from the internal back surface.

[2] The '**footprint**' refers in this case to the capacity of a region to support an average human consumer. The concept was first formalised by Professor Bill Rees (University of British Colombia) in 1992, and was expanded by Wackernagel and Rees in 1996. Our ecological footprint is measured in units called Global hectares (Gha)

A **Global hectare (Gha)** is roughly defined as a hectare with a biological productivity that is equal to the world average. The planet currently has about 11.2 billion hectares of biologically productive surface, or roughly one quarter of the total surface area. These productive hectares include 2.3 billion hectares of ocean and inland water and 8.8 billion hectares of land, and they represent the total surface area of the planet that sustains humanity.

[3] The **I = PxAxT** equation was first proposed by Stanford professors Paul Ehrich and John Holdren in 1971. While not offering any precise means of measuring the individual factors in the equation it still serves as an excellent general guide.

[4] Carl McDaniel, David N. Borton. "**Increased Human Energy Use Causes Biological Diversity Loss and Undermines Prospects for Sustainability.**" *BioScience*, Vol.52 No.10, pp.929–936. (October 2002).
http://www.csa.com/discoveryguides/ern/04jun/abstracts-f.php#c33

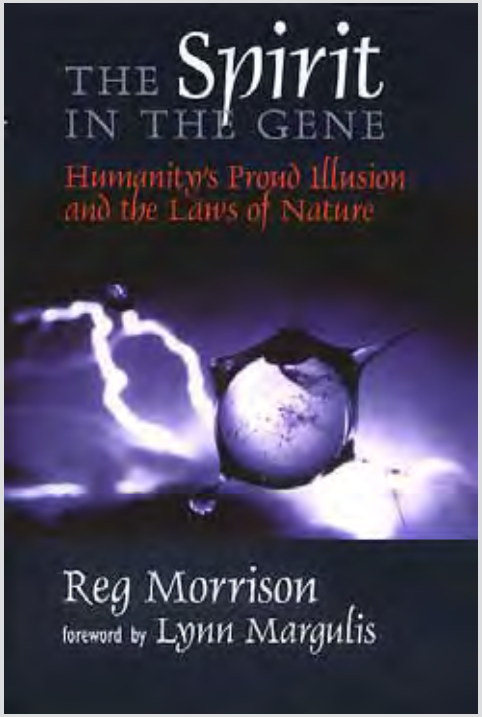
[5] Selye's **General Adaptation Syndrome** (GAS) is an automatic plague limiting mechanism that appears to be common among animal species. It may even exist in rudimentary form throughout the biota.

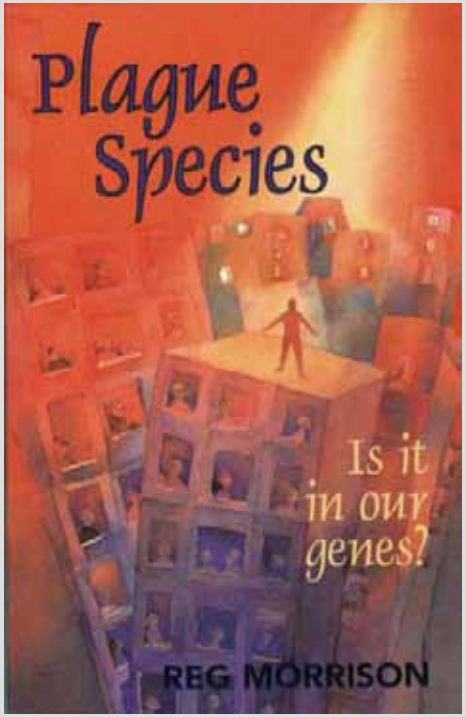
[6] A **plague** is commonly defined by exponential population growth. This means growth that regularly increases by a fixed percentage over a given period, such a year. This explosive growth is usually followed by an equally abrupt population collapse.

In an essay entitled ***"The Principles of Population***" in 1798, the Rev. **Thomas Robert Malthus**, a British scholar and cleric, proposed that fecundity increased on an exponential scale but agricultural production only increased on a linear scale. The final outcome of plague growth was therefore guaranteed to be overpopulation followed by mass starvation and population collapse.

[7] The **Easter Island Syndrome** refers to the combination of Malthusian and GAS factors that orchestrated the collapse of this vibrant but isolated Pacific culture during the 17th and 18th centuries. The population grew exponentially from a handfull of Polynesian settlers who landed there about 1500 years ago to about 10,000 peple in the 16th century. Having cleared all the land and chopped down all the trees the population began a precipitous decline that almost led to their total extinction early in the 18th century.

[8] **Jevon's Paradox** states that as technologies improve their energy efficiency they become more widely used, thereby cancelling out any energy savings that they promise. In fact, 'economical innovations' usually lead to greater energy consumption.William Stanley Jevons first proposed this paradox in his book "The Coal Question" (1865) in which he noted that improvements in steam engine efficiency had led to vastly greater coal consumption. The same argument clearly holds good for modern technology, and especially for those innovations touted as 'scientific breakthoughs'.





Reg Morrison's major book on human evolution, ***The Spirit in the Gene,*** was originally published in 1999 by Cornell University Press, New York. It was republished in 2003 by New Holland, Sydney, under the title ***Plague Species: Is it in our Genes?.***

In it he summarises the massive impact that humans have had on the biosphere, and then explores the evolutionary origins of the behaviour that produced this extraordinary impact. He delves into the many advantages that the development of mystically reinforced tribalism bestowed on our under-endowed species and warns that mysticism now has a second, much darker evolutionary role to play.

Other books on evolutionary topics by the same author:

The Voyage of the Great Southern Ark (Lansdowne Press, Sydney, 1988). A diary of Australia's evolution.
This was released in America under the title: ***Australia, The Four-Billion Year Journey of a Continent***.
A revised edition was published in 2003 by Reed-New Holland Sydney as ***Australia, Land Beyond Time.*** and this was released in America under the same title by Cornell University Press.

For Australian High Schools (years 11 and 12):

The Diary of You (Biology). Publisher: Sainty & Associates, Sydney, 2008.
Australia's Four-Billion-Year Diary (Earth Science). Publisher: Sainty & Associates, Sydney, 2005.

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