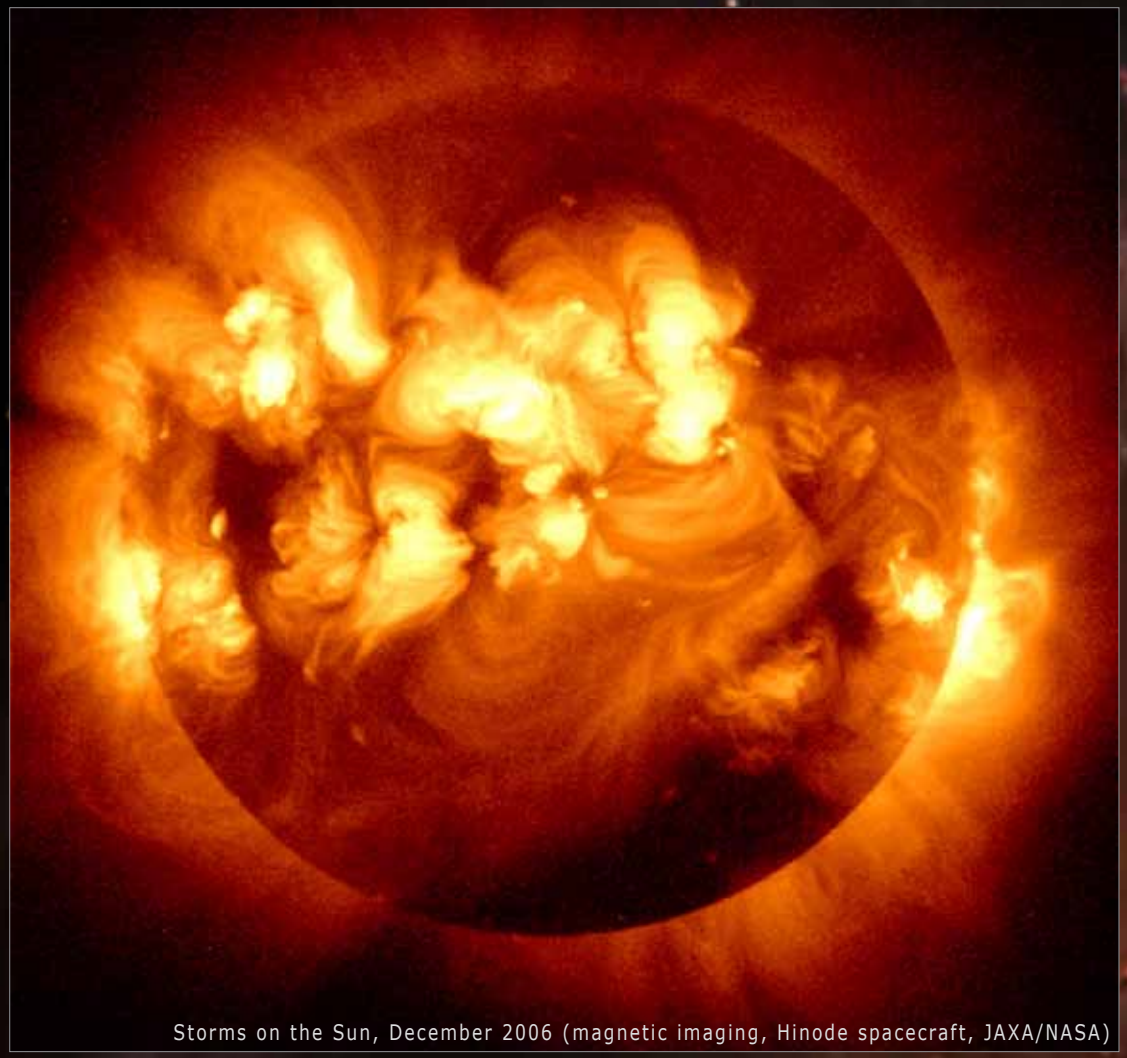
LIFE'S MAKER ...



Storms on the Sun, December 2006 (magnetic imaging, Hinode spacecraft, JAXA/NASA)

AND BREAKER

An uncensored assessment of our future on this hydrogen-regulated planet.

Reg Morrison

Foreword

All science-dependent culture is founded on the following beliefs:

- **Life is carbon-based.**
- **Evolution is Progressive.**
- **Humans are highly evolved and essentially distinct from all other species**

All three beliefs are fundamentally flawed. The facts are:

- **Life is hydrogen-based.**
- **Evolution is not Progressive. It denotes increased energy debt.**
- **Humans are thoroughly typical components of the Earth's biota.**

With this in mind ...

THE LAWS OF THERMODYNAMICS

The universe is a single Chaotic energy system that is entropic (running down). It is therefore governed by the two primary laws of Thermodynamics:

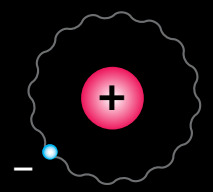
First Law: **Energy can neither be created nor destroyed ($E=mc^2$).**

It can be transformed from one state to another, but each change of state dissipates energy.

Second Law: **Energy only disperses.**

It flows from regions that are energy rich to regions that are energy poor.

The main energy carrier throughout the cosmos is hydrogen ...



- **Hydrogen constitutes ~90% of the known matter in the universe.**
- **It consists of just a single proton attended by a single electron.**

The weakness of this atomic alliance allows the partnership to be broken relatively easily and enables both the proton and the electron to make other molecular associations and perform other roles during the thermodynamic dissipation of energy.

LEFT: The vast clouds of dust and glowing gases that surround the Horsehead Nebula (in Orion's belt) reveal their primary component, hydrogen, by its reddish colour. All other wavelengths were filtered out during a seven-hour exposure made by astronomers at the Star Shadow Remote Observatory (www.starshadows.com/gallery/) in New Mexico, USA. This hydrogen image was then superimposed on a second (unfiltered) image that showed the underlying structure.

The Horsehead Nebula lies some 1,500 light years from Earth, and one of the three major stars from Orion's Belt appears left of centre.

CHAOS THEORY : 'The Butterfly Effect'

Mathematician and meteorologist Edward Lorenz first formalised this proposition in a paper entitled "Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?" In a paper delivered to the American Association for the Advancement of Science in 1963 Lorenz proposed that small differences in the starting state of a dynamic energy system can lead to enormous differences in its final state. The patterns of energy dissipation that characterise such systems are essentially fractal (repetitive but non-identical). These are the hallmarks of Chaos.

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 the entire cosmos. As a by-product of the laws of thermodynamics it prevails at all scales of magnitude from the cosmic to the microcosmic, and permeates all energy systems, biological and non-biological. It is ubiquitously displayed in the fractal patterns of energy dissipation that characterise every aspect of our planet from its core to its outer atmosphere, and the basic energy courier that achieves this is the hydrogen atom.

As an interchangeable expression of the Earth's crust, life too, is Chaotically fractal and fuelled by hydrogen, and it graphically displays this in all aspects of its growth, reproduction and diversification.*

Earth rises over its barren moon. (William Anders, NASA)

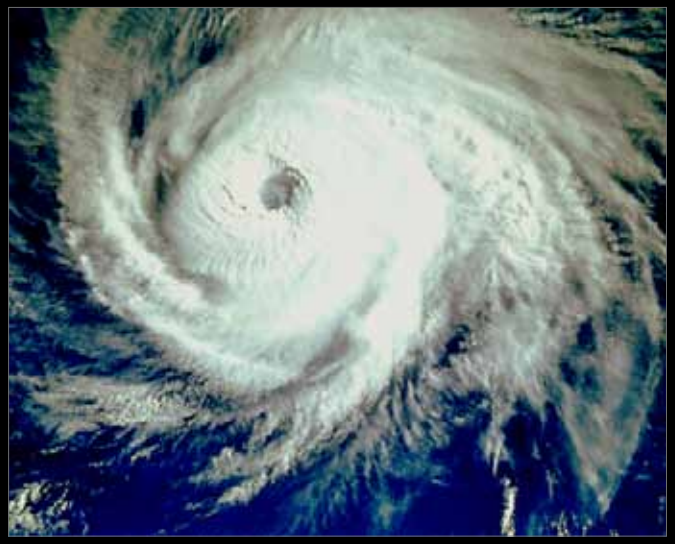
Earth proclaims its fertility by the pale blue moisture-laden atmosphere that swirls Chaotically around it. Built up by four billion years of biological activity, Earth's atmosphere displays the patterns of energy dissipation that characterise the whole universe, and they in turn, are driven by the growth, death and decay of the vast biota that enlivens our Chaotic biosphere.

A fern recommenses fractal growth after a fire (NSW).

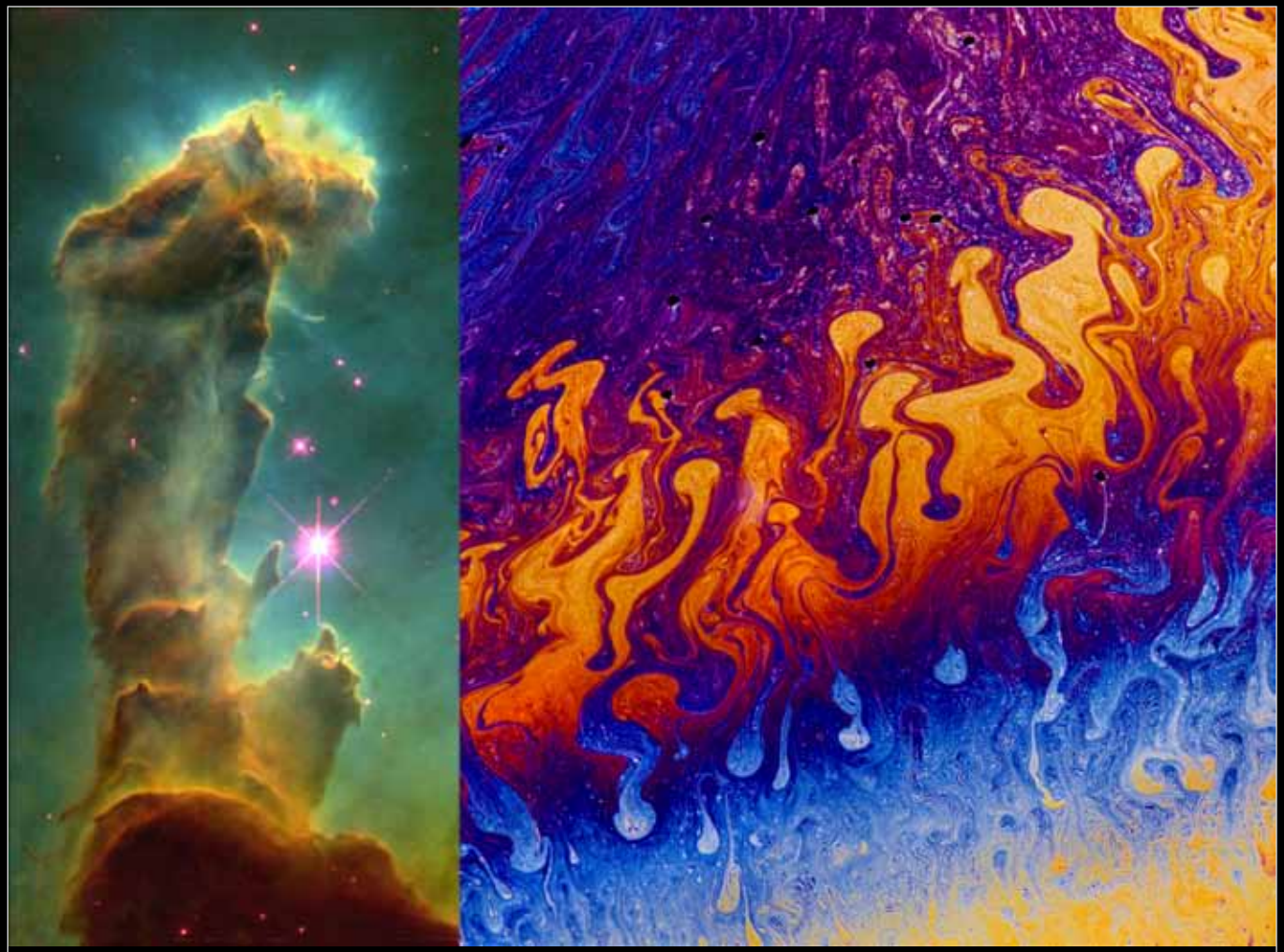
*See also: *'Fingerprints of the Cosmos'*

CHAOS
in the cosmos

Whirlpool Galaxy, Hubble Telescope (NASA).



Hurricane Odessa, Gulf of Mexico (NASA).



ABOVE: The universal rules of Chaotic energy dissipation apply at all scales of magnitude from the cosmic to the microcosmic. The towering plume of dust, gas and nascent stars in the Eagle Nebula (*LEFT*) are echoed by the swirls of rainbow colour that characterise the surface of a soap film (*RIGHT*) as it looses energy. Although reduced to only two dimensions, the flow of colour in the soap film displays the same kind of fractal patterns of entropy that the nebula displays because it is governed by the same thermodynamic laws that define all cosmic structures (see next page).

CHAOS
in microcosm

The gaudy tides of rainbow colour that drift across a soap film shortly before it bursts reveal the chaotic and fractal patterns of energy flow that chacterise the universe.

The colours that we see in a soap-film are produced by wave interference between light rays bouncing from the front surface of the film and those reflected from the film's internal rear surface.

The uneven evaporation of water molecules from within the film reduces the distance between the front and rear surfaces. This changes the pattern of wave interference between the two reflections and results in a colour change. Each colour change thereby betrays an energy dissipation.

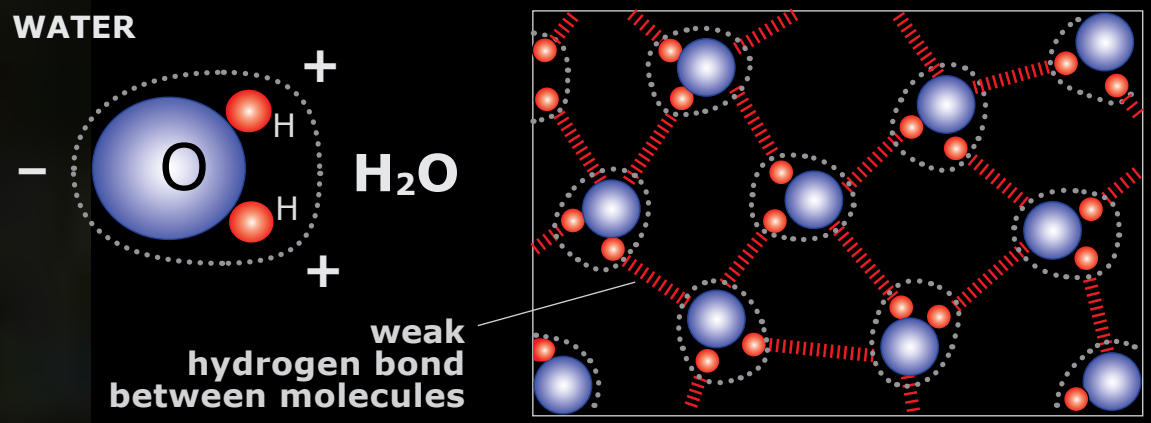
Energy dissipation in hydrogen's oxide

The evaporation of water molecules from this soap film occurred in perfectly still air. The flow of colours consequently expresses the fractal patterns of energy flow that typify the process of energy dissipation throughout our thermodynamic universe.

This soap film betrays disturbance in the flow of air surrounding the soap film. (I breathed out just before taking the shot). This minor disturbance to the evaporation process was enough to entirely rearrange the pattern of energy dissipation within the film.

LIFE'S MIDWIFE

Life's enabling medium, water, is yet another artefact of the weak hydrogen bond. The polarity of its molecules (due to the lopsided attachment of two hydrogen atoms to an oxygen atom) also makes it invaluable as a universal solvent and a medium of transport for life's nutrients.



The weak and flexible bonds that link molecules of dihydrogen monoxide (H_2O) also allow it to remain 'watery' over a huge temperature range (0°–100°C). Most crucially, this peculiar bonding causes water to lose density and expand between 0°C and 4°C, a property that forces ice to float. If water behaved like other solvents and increased in density as it froze ice would sink and the seas would freeze from the bottom upwards. In such inhospitable circumstances life may not have survived.

Water's stability also helps to insulate life from temperature extremes that would otherwise destroy it, meanwhile, the fact that it takes a great deal of extra heat to transform liquid water into water vapour enables many plants and animals to endure extremes of heat that would otherwise desiccate them.

When Stanley Miller and Harold Urey decided to run a continuous electric current through water vapour plus a little methane (CH_4), ammonia (NH_3), and hydrogen gas (2H), they hoped to simulate the kind of environment that would have prevailed on the planet soon after its birth. This 1953 experiment by Miller and Urey showed that a number of biological compounds, including several amino acids essential to life, could be readily synthesized in such moist, electrically-charged conditions. Hydrogen-loaded niches like these still exist inside alkaline vents on the sea floor. And significantly, archaebacteria still thrive there.

This raindrop encapsulates a midge that died on the strands of a spider's web. The web silk itself is a glandular secretion of pure amino acid.

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

LIFE IS HYDROGEN BASED

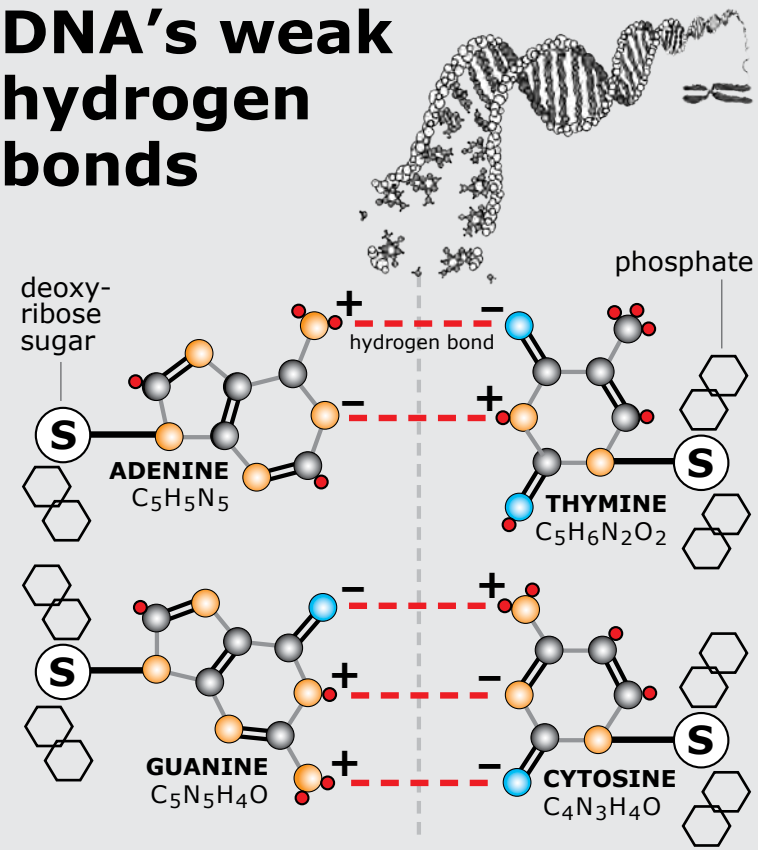
Carbon does indeed provide most of the building material that life uses to construct its mansions, but it is hydrogen that switches the lights on and off inside those mansions. As the smallest and most abundant element in the universe, hydrogen possesses only a single promiscuous electron and forges bonds that are about 5% as strong as any other. 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. A series of hydrogen-loaded carbon tags along the side rails of DNA helps to regulate this process by controlling how tightly it is folded. The hydrocarbon tags alter the folding pattern and tend to 'switch off' associated genes. Meanwhile, the pattern of tagging (methylation) is accessible to environmental interference.*

Hydrogen enters the biota via bacteria (prokaryotes). Some bacteria harvest it directly from volcanic gases while others (cyanobacteria and plant chloroplasts) harvest their hydrogen by using sunlight to split water molecules.

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. "We may regard living matter in its entirety then, as the peculiar and unique domain for the accumulation and transformation of the luminous energy of the Sun" (Vernadsky, 1945). Hydrogen not only fires the stars and lights the universe, it performs a similar role in the moist microcosmos of the Earth's biosphere. As the primary shaper of our planet's energy gradient, hydrogen is also the maker and breaker of all life.

DNA's weak hydrogen bonds



KEY

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

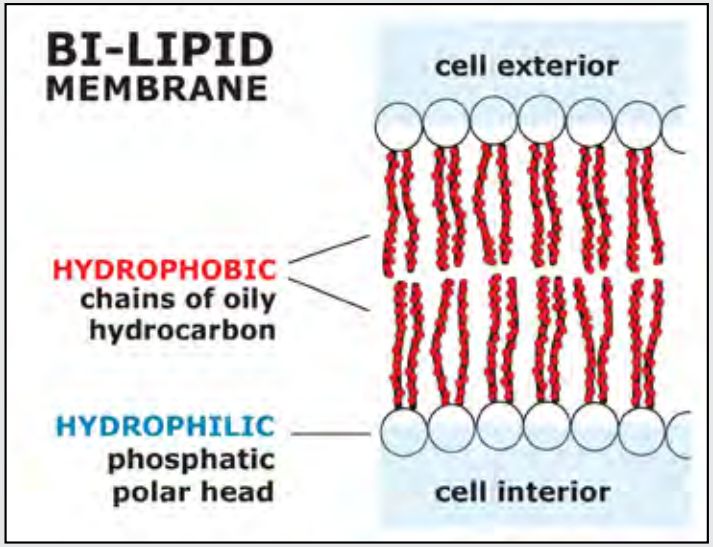
As the primary by-product of the Big Bang, hydrogen constitutes 90% of all the atoms in the universe and provides the basic energy coinage for the chaotic entropy of its thermodynamic structures. Hydrogen also forms the basic coinage of all biological energy and provides the weak chemical bonds that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

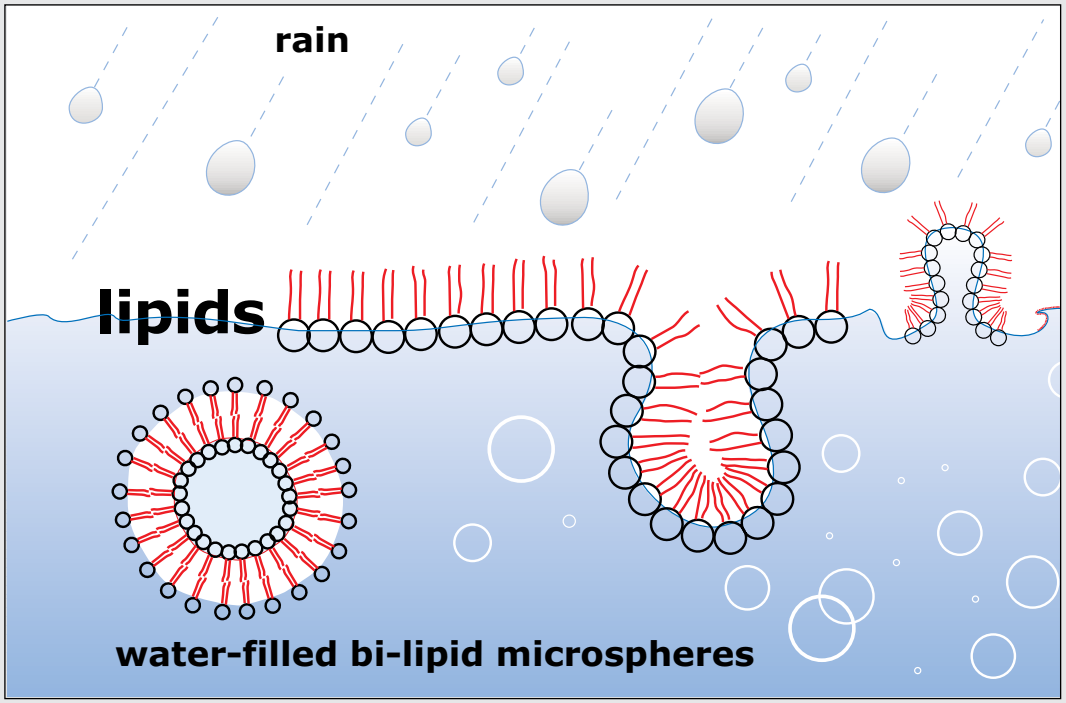
*See Appendix 1 ('Epigenetics')

HYDROGEN HELPS TO DEFINE LIFE

A single carbon atom is stable and has no electrical charge, but the attachment of hydrogen atoms bestows an electro-magnetic polarity on the molecule. Chains of hydrogen-loaded carbon atoms (lipids) are strongly charged and hydrophobic (they repel water). This enables the chains to lock together to form tough, twinned membranes (bi-lipids) that are both impervious and yet hydrophilic (water-loving) on both sides.

Four billion years ago the continual assault from volcanic eruptions and comet impacts ensured that fragile genetic material could only survive and replicate in water, and then only when it was enclosed and protected within bilipid microspheres.





This is still essentially true and is exemplified by frogs. Most species lay their eggs within a protective mass of bilipid spheres known as frog spawn (BELOW).

A tadpole begins life amid a glittering galaxy of bilipid spheres. NSW.

THE SEEDS OF LIFE

The seeds of life may well have been sown in submarine volcanic vents or in boiling mud pools like the one shown here. The essential ingredients were hydrogen gas and hydrogen-loaded compounds that were abundant in such volcanic environments.

These earliest organisms appear to have been archaic bacterial organisms (archaebacteria) that extracted from their surroundings all the hydrogen and carbon they needed for growth and reproduction, and they released any excess in the form of methane (CH_4).

Significantly, they are exclusively abundant inside and around a few porous alkaline vents on the sea floor known as 'white smokers'. So these may well have been life's birthplace.

Such methane producers (methanogens) are still dominant throughout the planet's crust and this suggests that their total biomass may even exceed that of all surface life.

Meanwhile, vast quantities of their waste gas have become trapped in the lattice of ice crystals that characterise many sea floors around the world. Since methane is also a potent greenhouse gas, the stability of these reservoirs is now of critical importance to all life.

Boiling mud, Rotarua, New Zealand.

METHANOGENIC BACTERIA

Archaebacteria that discharge methane as a waste gas appear to have been major players in governing the planet's climate throughout its existence. Because methane is easily trapped in the icy crusts that form on many seafloors, vast reserves of this bacterial methane tend to accumulate during the planet's cooler periods. Whenever these submarine ices (hydrates) begin to melt and release their methane, it produces an explosive temperature increase. The recent collapse of polar hydrates therefore represents a major threat to our species (see pp. 44-53).

HARVESTING SOLAR ENERGY

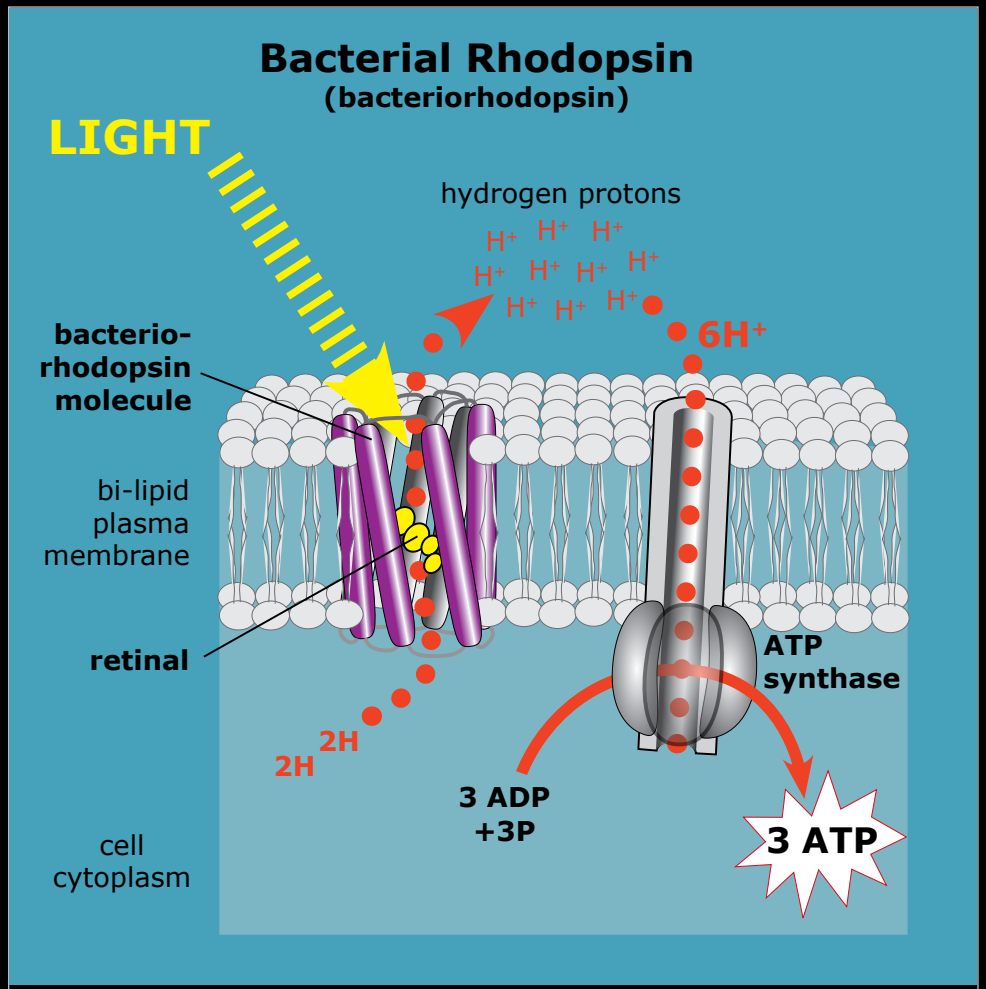
One of life's earliest methods of harvesting the energy in sunlight was via molecules of rhodopsin that were embedded in the plasma membranes of archaebacteria (archaea). Its purplish molecules change their shape slightly when hit by photons of light and during this process the retinal component robs an electron from hydrogen and pumps its proton out of the cell.

This repeated process creates a charge potential across the membrane, and where ion channels allow re-entry, the hydrogen protons flood back inside the cell. This torrent of incoming protons enables enzymes to build adenosine triphosphate (ATP), the universal energy carrier that fuels all biological growth, reproduction and repair.

In this fashion bacterial membranes that are rich in rhodopsin provide a reliable power source that can maintain the organism's metabolism where other energy sources, notably oxygen, are scarce. These rhodopsin molecules are consequently abundant in the membranes of those archaebacteria that inhabit extreme environments such as hot volcanic pools and hypersaline, acid or alkaline waters that other life-forms are unable to endure.

Archaebacteria's preference for these extreme, hydrogen-rich, oxygen-poor environments suggests that life may well have originated in such turbulent, inhospitable places.

They appear to have pioneered this light-based metabolism more than 3.5 billion years ago, and although the details of that original process are uncertain, what is certain is that rhodopsin-loaded bacteria still use light to disect hydrogen atoms, produce ATP, and thereby empower the cell's metabolism.



Life's oldest power station

Thanks to rhodopsin life was at last able to tap directly into the raw energy radiating from the solar system's primary energy source, the Sun. No longer would life depend exclusively on the energy emanating from the Earth's core. Rhodopsin thereby represented a first step in life's gradual colonisation of the planet's well-lit surface.

EMPLOYING HYDROGEN'S ENERGY

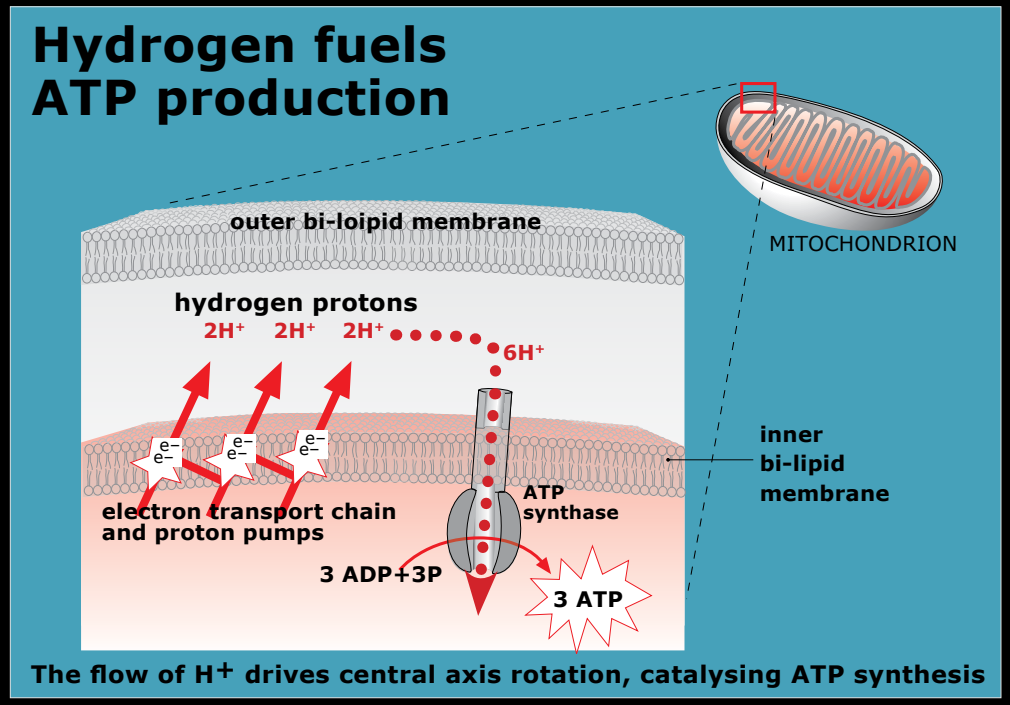
Adenosine triphosphate (ATP) is the universal intra-cellular energy carrier that underpins the growth, reproduction and daily activity of all life on Earth, and its construction is fuelled by hydrogen.

ATP and its precursive forms, ADP and AMP, consist of a DNA nucleotide (usually adenine and a sugar), plus a detachable phosphate tail. Its usable energy lies in this 'semi-trailer' construction and although the phosphate modules are not directly coupled by hydrogen, an electron-stripping process that occurs in bilipid membranes supplies a torrent of hydrogen protons that trigger the coupling of the phosphate tail to the adenosine-sugar component at its head.

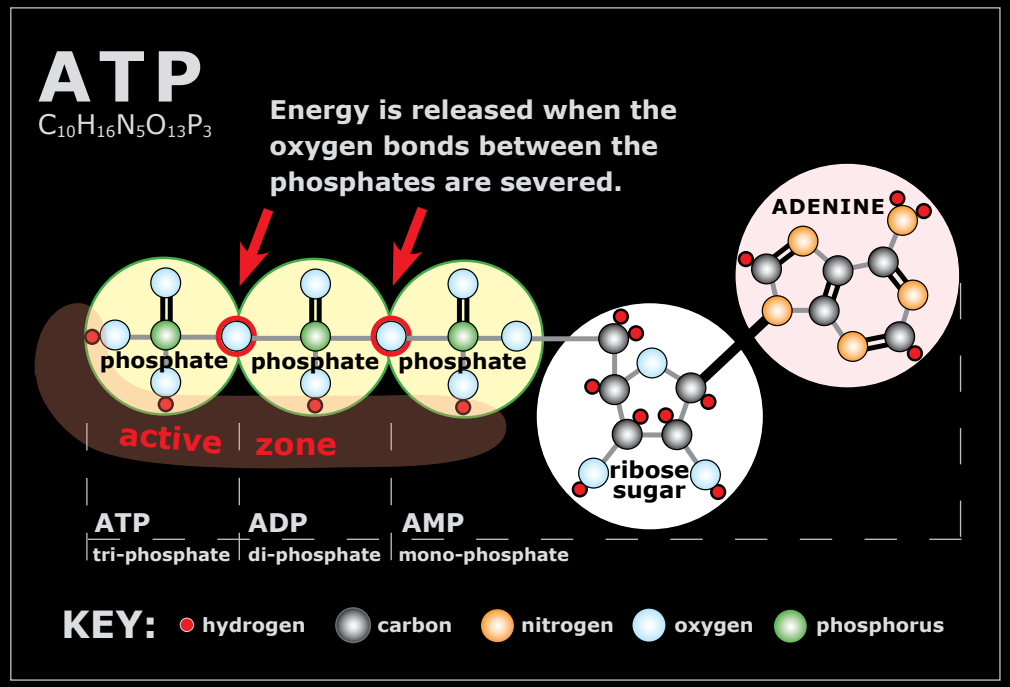
The enzyme that mediates the coupling process is ATP synthase, and when the cell requires a burst of energy, it gains this simply by uncoupling one or two of ATP's phosphate modules.

We know this process represents an ancient bacterial innovation because it characteristically occurs in mitochondria, a strain of purple bacteria that became embedded in all eukaryote cells more than two billion years ago. And we know that mitochondria are bacterial because, like most eukaryote organelles, they are run by their own DNA and clone themselves independently inside the host cell.*

When some bacteria developed the ability to manufacture ATP and develop aerobic respiration, they tapped into a far richer source of metabolic energy than was available to their fermentative ancestors. Where a sugar molecule could yield only 2 molecules of ATP via fermentation, respiration yielded 36 molecules of ATP. Inevitably, ATP is now the universal fuel unit used by all plant and animal cells, and it pivots on the flow of hydrogen through the biosphere and its biota.



The flow of H^+ drives central axis rotation, catalysing ATP synthesis



* See Appendix 2 ('Endosymbiosis')

THE LIFE OF BRINE

Primordial bacteria harvested hydrogen to fuel their metabolism by extracting it from volcanic gases or by fermenting sugars. As solar radiation increased however, rhodopsin released life from the darkness of its birplace in submarine 'smokers' and volcanic muds.

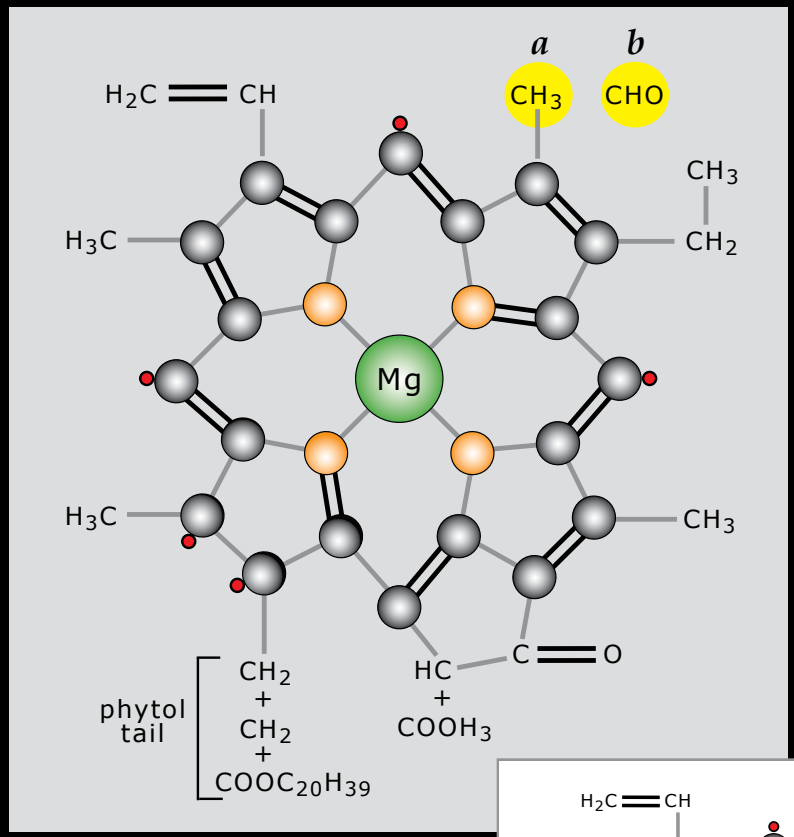
As the Sun's light continued to intensify, archaebacteria that happened to have some carotenoid hydrocarbons in their membranes survived best. These orange-red pigments acted as sunscreens that prevented rhodopsin 'burn-out'.

The colourful descendants of those sunscreened bacteria are still dominant in extreme habitats, and most hypersaline and acid lakes are now tinted by the blooms of rhodopsin-based archaebacteria that thrive there.

RIGHT: Lake MacLeod, north of Shark Bay on Australia's west coast, is one such environment. Its salinity is continually recharged by salt-laden sea winds and a hypersaline aquifer that underlies the region. It also supports a salt farm at the lake's southern end.

Lake MacLeod, Western Australia.

CHLOROPHYLL: the molecule that changed the world

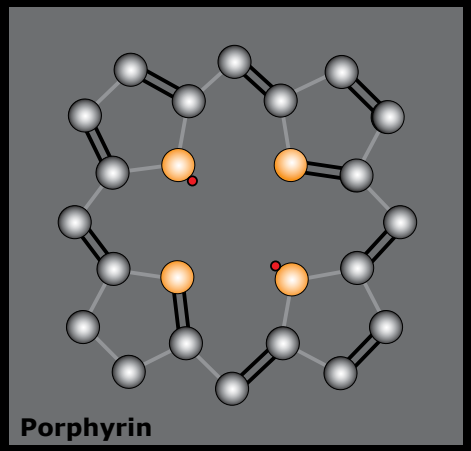


Somewhere between 3 billion and 2.8 billion years ago, a new system of photosynthesis began to transform the bacterial world. It was based on a ring of carbon and nitrogen atoms known as porphyrin. When an atom of magnesium became embedded in its core it enabled cells to harvest 18 times more hydrogen than their ancestors could extract by other means. Such success ensured that these chlorophyll-equipped bacterial forms would not only come to dominate the world's marine biota, they would eventually underpin almost all of the world's surface life.

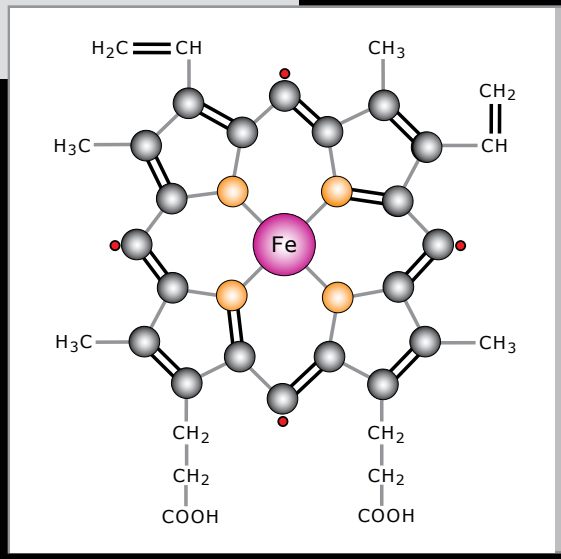
KEY

- hydrogen
- carbon
- nitrogen
- magnesium
- iron

In obedience to the universal laws of thermodynamics however, this highly efficient energy extraction process also entailed a proportionate environmental fee. These new cells dumped 18 times more oxygen waste than their ancestors, and this highly toxic fallout soon began to threaten all life. Some of the very first signs of this ominous biological fallout can still be detected on a few ridge lines in north-western Australia where a scraps of old seabeds remain intact ...



Porphyrin



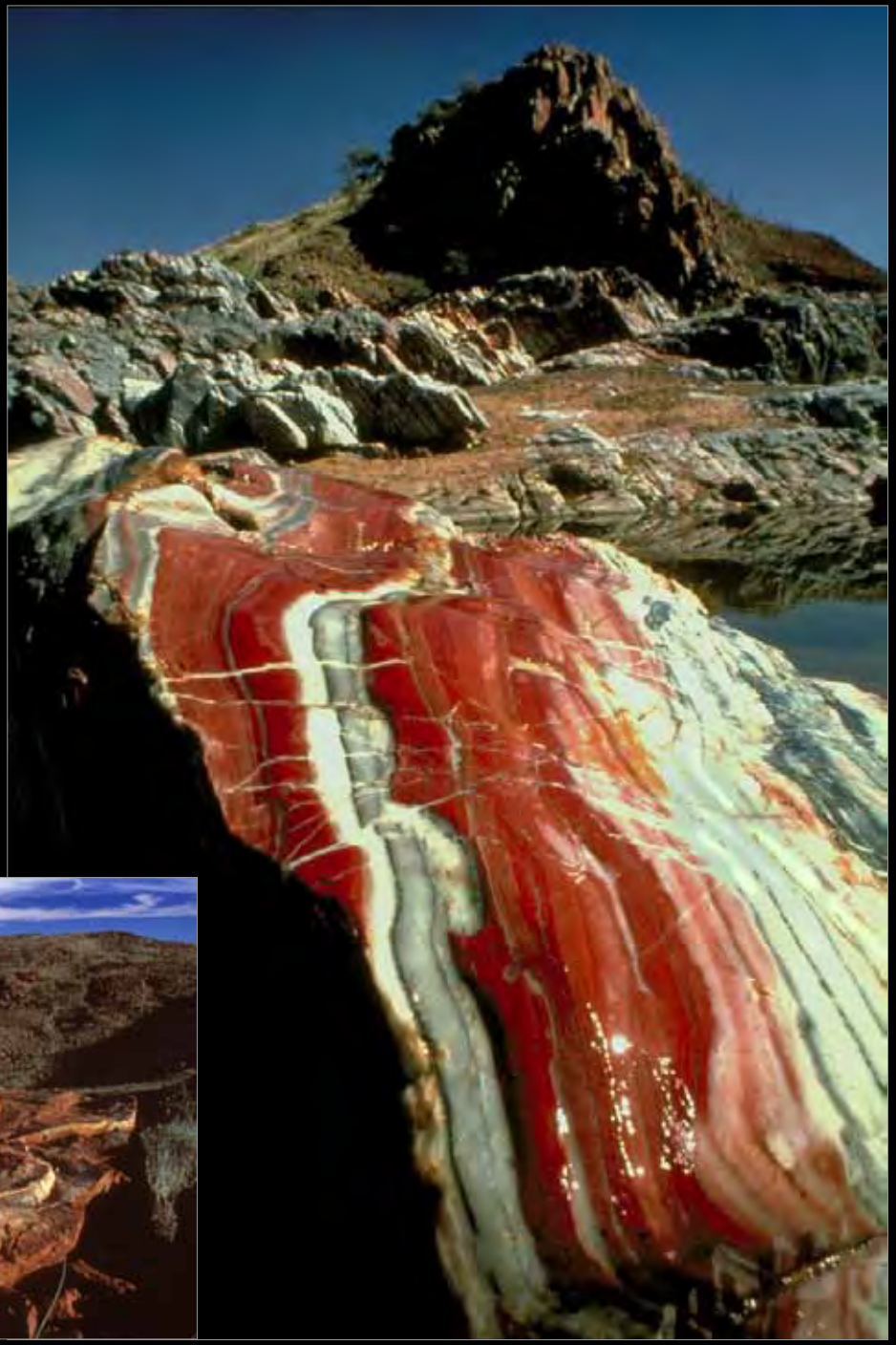
HAEMOGLOBIN

Chlorophyll has a molecular twin, haemoglobin, that is also based on a porphyrin ring, but with an iron atom at its core rather than magnesium. Since at least one primitive sulfur bacterium uses this molecule, it too, may have evolved about the same time as chlorophyll—just as levels of free oxygen were beginning to rise. Because haemoglobin's iron core was able to attract and safely carry atoms of oxygen, it became the pivot upon which the oxygen-dependent animal world would turn.

EVOLUTION'S ARCHIVE

Scattered across several crumbling ridge lines in north-western Australia there are fragments of a seabed that has monumental significance for us. The region's extraordinary tectonic stability for the past 3.5 billion-years has preserved the ripples in its once-muddy surface, so you can't help but notice the layered 'bubbles' that puncture its surface. Each puncture is the tip of a pile of limey waste left by a colony of microscopic bacteria that once lived there. Run a finger over those crumbling layers and you trace out life's oldest tangible signature on the face of the planet (BELOW).

A little to the east, the rocky bed of the Coongan River features a broad seam of banded jasper known as the Marble Bar. Several ribbons of rich red silica run through it (RIGHT). Stained as they are by iron oxide, these layers represent one of the world's oldest signs of free oxygen discharged by photosynthetic bacteria. The iron would have come from the seawater itself which was loaded with soluble (ferrous) iron at that time. Chlorophyll may not have been involved in this early photosynthetic process but the energy that powered it may well have come from rhodopsin.



The Chlorophyll Revolution

Weathering gradually beneath a halo of southern stars this huge stromatolite fossil in north-west Australia first appeared ~2.72 billion years ago in the warm shallows of a lake or bay at the edge of a landmass that was to became the tectonic cornerstone of the continent—a region known as the Pilbara. The abrupt appearance of huge stromatolites in the fossil record at this time hints at the explosive success of chlorophyll-loaded cyanobacteria all round the world.

A fossil stromatolite, 2.72 billion years old, about 2 metres tall, near the Nullagine R., WA.

Hamersley Ranges, Pilbara, WA

Australia's massive iron-ore reserves offer eloquent testimony to life's hunger for hydrogen. Up to 2.5 km thick in places this iron-rich seabed represents the greatest pollution event that life has ever faced. It is the rusty fallout from vast blooms of chlorophyll-charged bacteria that flourished in the world's seas between 2.7 and 2 billion years ago. Via photosynthesis they discharged sufficient oxygen waste to rust all of the soluble iron that had washed from the magma-covered Pilbara and fallen from the skies as iron-rich dust following several gigantic cosmic impacts.*

Hamersley Gorge, Hamersley Range, Pilbara, WA

Red Gorge, Hamersley Range, Pilbara.

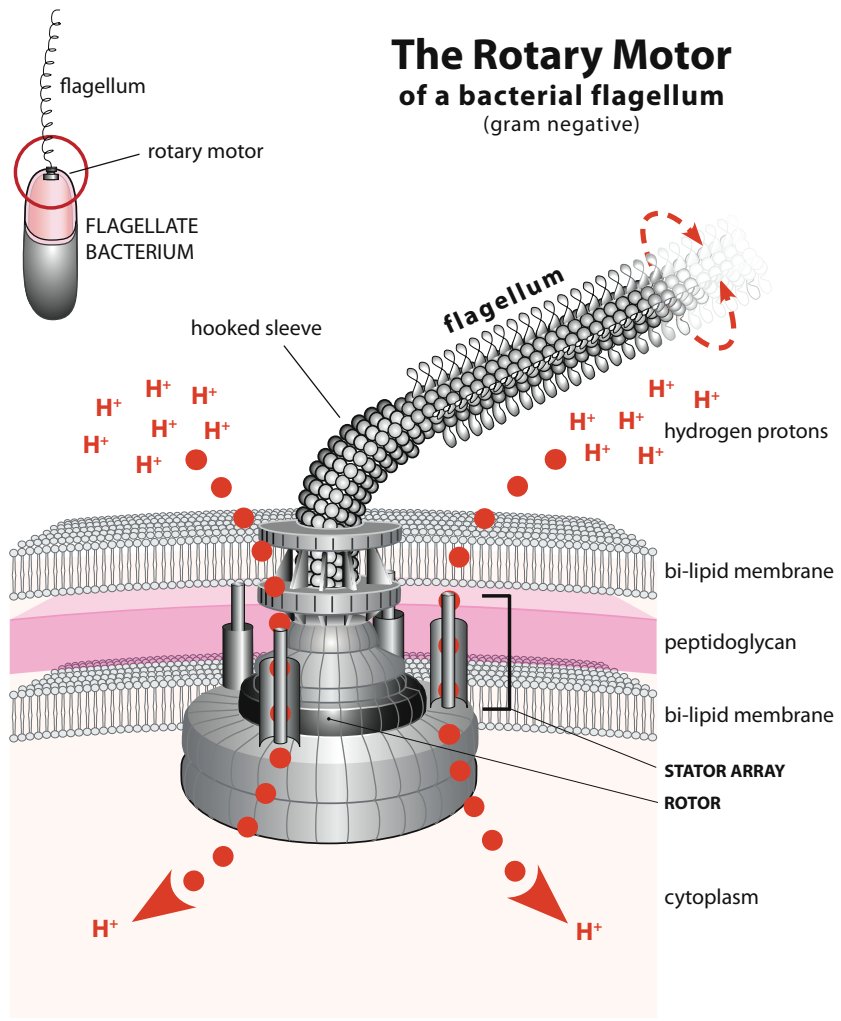
* The Pilbara, Life's Turning-point

HARVESTING HYDROGEN

About 2.5 billion years ago many of the world's shorelines would have looked like this. Some of these stromatolites have been growing in the hypersaline shallows of Shark Bay for several thousand years, and many now stand more than one metre tall. It is likely that the high salinity of the water limits the range and number of predator species that usually feed on cyanobacteria.

These stromatolites line the inner recesses of Shark Bay on the west coast of Western Australia.

THE FLAGELLA MOTOR: Evolution's Unique Rotary Engine



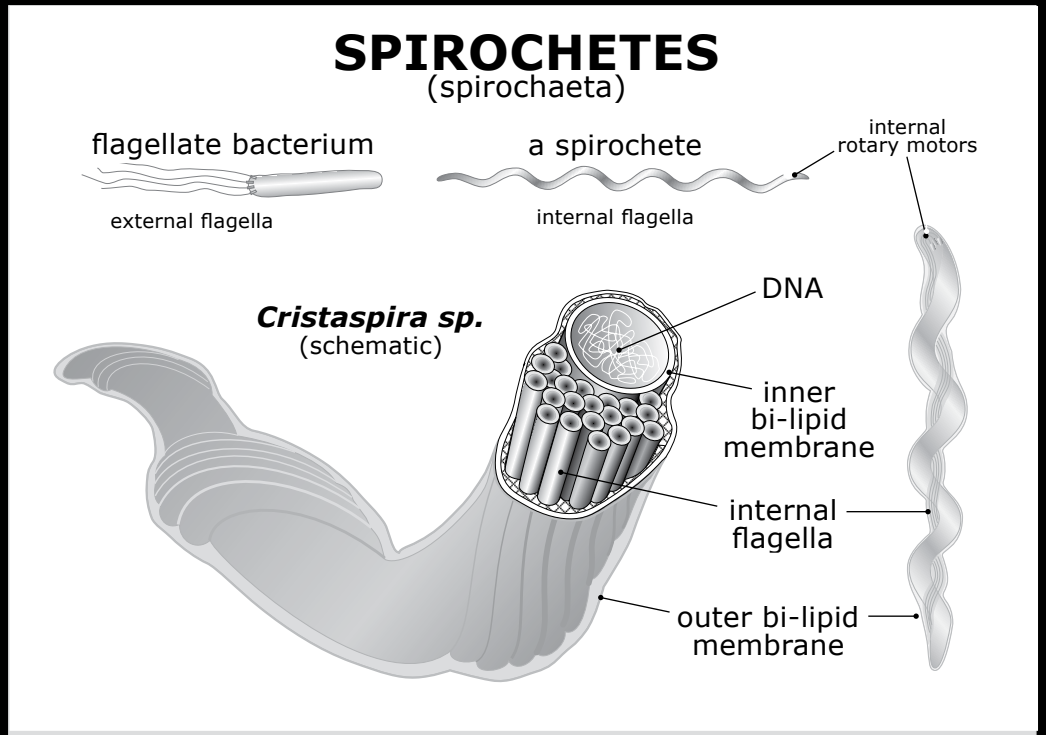
The flagellum motor is driven by the flow of hydrogen protons through the stator array, and the rotor spins in either direction according to local stimuli. Speeds up to 400 revolutions per second have been recorded.

Based on Keiichi Namba, Osaka, and David Blair, Utah (pers. comm.), and on microscopy by David DeRosier et al, Brandeis

Hydrogen's other crucial role is to drive the only rotary motor ever to emerge from the process of biological evolution. They are the world's smallest engines and they drive the flagella of all swimming bacteria.

These motors are fuelled by protons mined from hydrogen nuclei that have been stripped of electrons. It takes up to 1000 protons to drive the rotor through a single revolution, yet these molecular engines achieve speeds of 300–400 revolutions per second. If scaled up, the motor can produce a torque equivalent to an 8-horse-power electric engine. Its fuel is generated by an electron-stripping process that occurs within the bi-lipid cell membrane and ejects a torrent of positively charged hydrogen protons outside the cell membrane. Too large to return unaided through the bi-lipid membrane, the protons pass easily through the 'stator' array that surrounds the rotor. When a significant charge gradient builds up between the proton-rich, positive exterior and the hydrogen-depleted, negative interior, the rush of protons re-entering through the stator spins the rotor and its hooked flagellum, creating a 'corkscrew' drive.

The hydrogen-powered flagellar motor enables many kinds of bacteria to move swiftly towards nutrient and away from potential threats. This mobility has enabled them to colonise the planet to the point where they now help to modify the Earth's crust, its atmosphere and its climate.



Evolution's Hydrogen-Fuelled 'Rockets'

Evolution probably produced its masterpiece of bacterial design, the spirochete, up to 2.5 billion years ago when flagellate bacteria became sleeved by an outer membrane. This not only gave their DNA added protection from oxygen, it also locked their flagella to their elongated bodies so that they were induced to rotate in unison. With all of its flagella motors running as one, a spirochete was able to corkscrew its way through a watery medium much faster than any other kind of flagellate bacteria.

Ten body-lengths per second is not an uncommon speed for some spirochetes. That is like a 2-metre-tall human lapping a standard 50-metre pool in just 2.5 seconds!

EVOLUTION'S UNIVERSAL FUEL

With hydrogen fuelling the entire biota, either via cyanobacteria and photosynthesis, or via mitochondria and ATP, the struggle to harvest sufficient hydrogen became an arms-race with few rules.

Any improvement in an organism's ability to harvest its hydrogen fuel invariably increased its chance of survival, and the presence of a reliable hydrogen source, such as water, was a major advantage.

The continual exchange of genetic information between bacteria meanwhile ensured that any advantageous adaptation developed by one organism, often became widely distributed throughout the regional biota in a relatively short time.

In this fashion life's primal hunger for hydrogen had initiated an unrelenting push for bigger, better hydrogen-harvesting machinery.

But there was a catch ....

Upgrading to better metabolic systems and more complex metabolic machinery invariably entailed a significant increase in an organism's energy budget. It not only locked the evolutionary process into escalating complexity, it locked it into escalating fuel consumption.

Here was a Faust clause in the evolutionary contract that would have lethal consequences for both winners and losers in the evolutionary arms-race, and those consequences would only increase with time as the biota became more complex and fuel became harder to find.*

Life's insatiable hunger for hydrogen is the primary driver of the process that we know as evolution.

*See Appendix 3 ('Faustian Bargain')

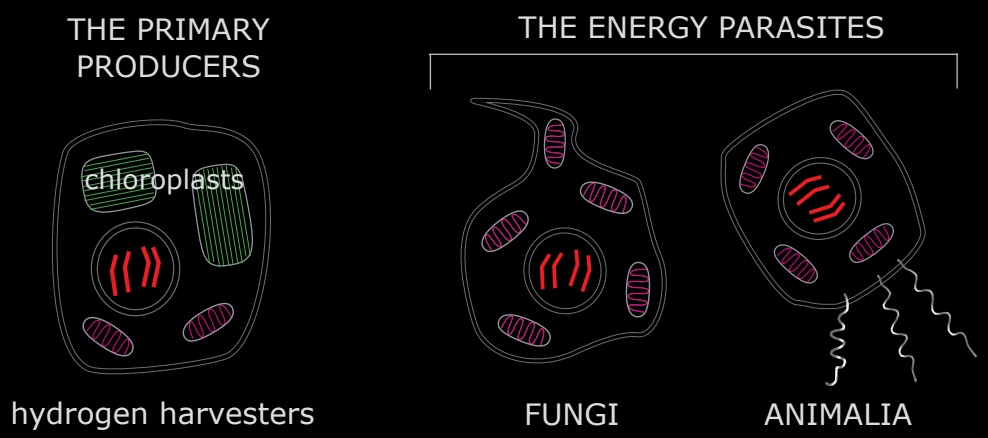
BACTERIAL CORPORATIONS

By about two billion years ago life's hunger for hydrogen had polluted much of the biosphere with its highly toxic waste gas, oxygen. This had given rise to an oxgen-tolerant third branch on the tree of life, the eukaryotes (cells containing nuclei and other structures).

These versatile cells fell into two basic groups: those with chlorophyll, and those without (fungi and animals).

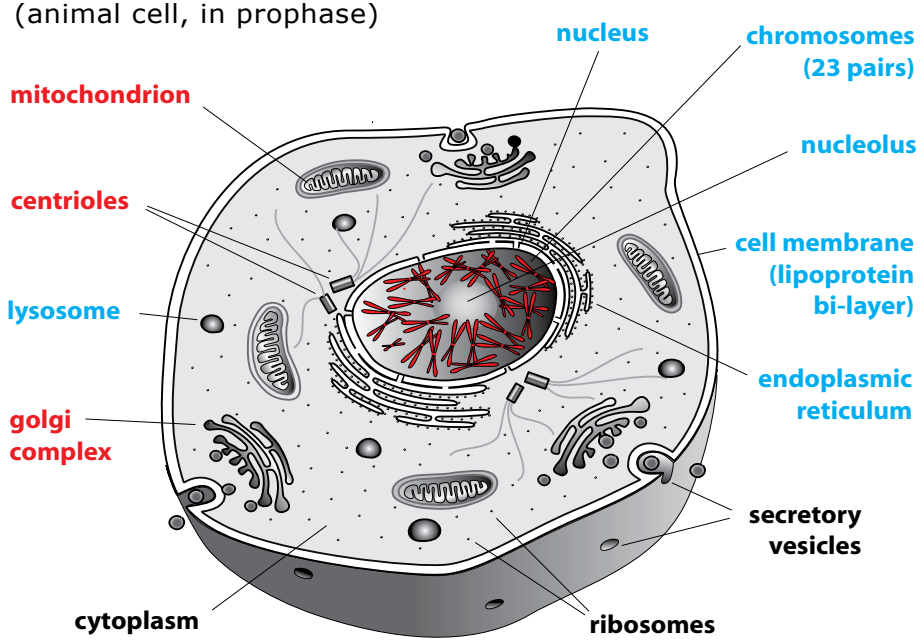
The chlorophyll-loaded chloroplasts that define green algae and green leaves evolved from cyanobacteria that had become enveloped by an archaebacterial 'host' when oxygen pollution began to pose a serious threat to all life. The exchange of goods and services that eventually developed between the host and its cyanobacterial partner was so successful that they thrived as a cellular unit.*

Eukaryotes are therefore divided into two main streams, those that havest hydrogen—the primary producers—and those that acquire their energy second-hand, either by eating primary producers themselves, or by eating species that consume primary producers.



EUKARYOTE

(animal cell, in prophase)



EUBACTERIAL ORIGINS	ARCHAEBACTERIAL ORIGINS

BLACK —structures common to both archaebacteria and eubacteria

EUKARYOTES

Each eukaryote cell is a bacterial corporation run by the large parliament of genes that is embedded in the organism's DNA and confined within the cell's nucleus. All of the other major structures (organelles) within the cytoplasm are relics of bacteria whose ancestors had either invaded the host as predators or had been enveloped by it as potential food. We know this because they still possess their own bacterial DNA and they replicate themselves independently by cloning.*

*See Appendix 2 ('Endosymbiosis')

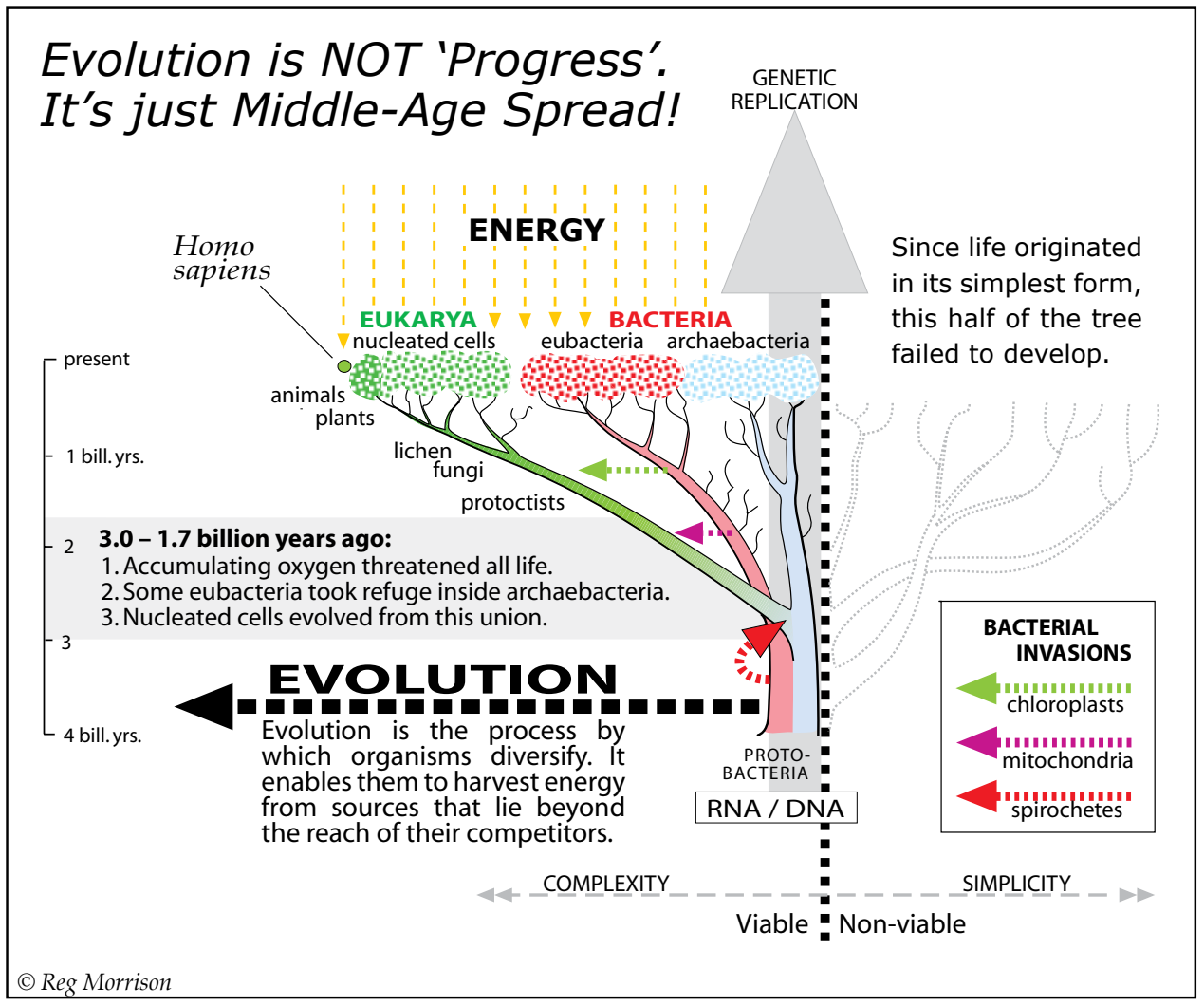
LIFE'S FAUSTIAN BARGAIN

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 cyanobacteria 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 hunting and 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 in turn made them far more vulnerable to extinction whenever the climate changed and their regional vegetation declined.

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



Evolution's Faust Clause

The evolutionary penalty invoked by the energy upgrade that followed the switch to energy parasitism exemplifies the Faustian nature of evolution in general, and of energy extraction in particular. We are about to suffer the evolutionary consequences of our massive energy budget.

*See Appendix 3 ('Faustian Bargain')

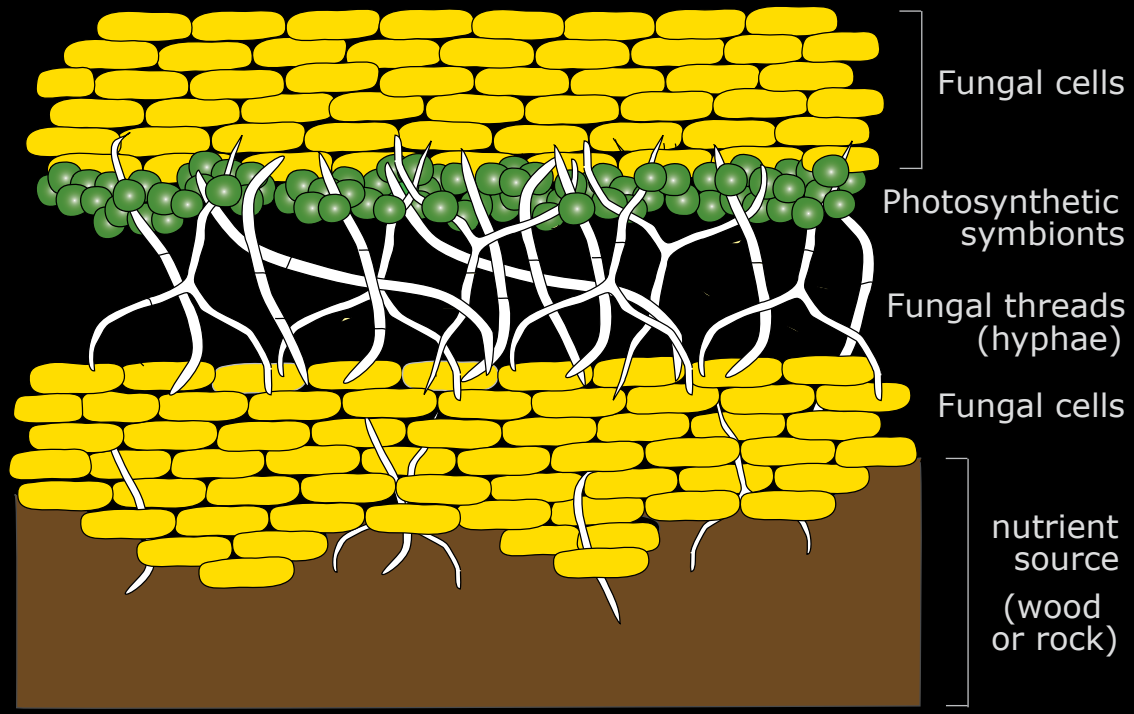
COLLABORATION SECURES LIFE'S BEACH HEAD

Until about 1,200 million years ago all life was confined to its birthplace, water. Life on dry land meant exposure to savage cosmic radiation, aridity, and a dearth of nutrient. Most species were not equipped for such hardship. The first pioneer was a fungus armed with chitinous walls, but it had to incorporate a photosynthetic partner to supply the hydrogen.

The cooperative partnership that evolved more than a billion years ago between fungi and their chlorophyll-loaded symbionts still plays a major role in the conquest of new land habitats all around the world. These durable partnerships are known as lichen, and the particular form the lichen takes largely depends on the nature of the fungi's symbiont. The most common symbiont is cyanobacteria but there are also a number of algae that can perform the same photosynthetic service.

A crustose lichen, Ben Boyd National Park, NSW.

A foliose lichen, Ben Boyd National Park, NSW.



Oxygen bubbles from cyanobacteria in a coastal spring, NSW.

SUMMARY

Life is hydrogen-based.

Life dissipates energy.

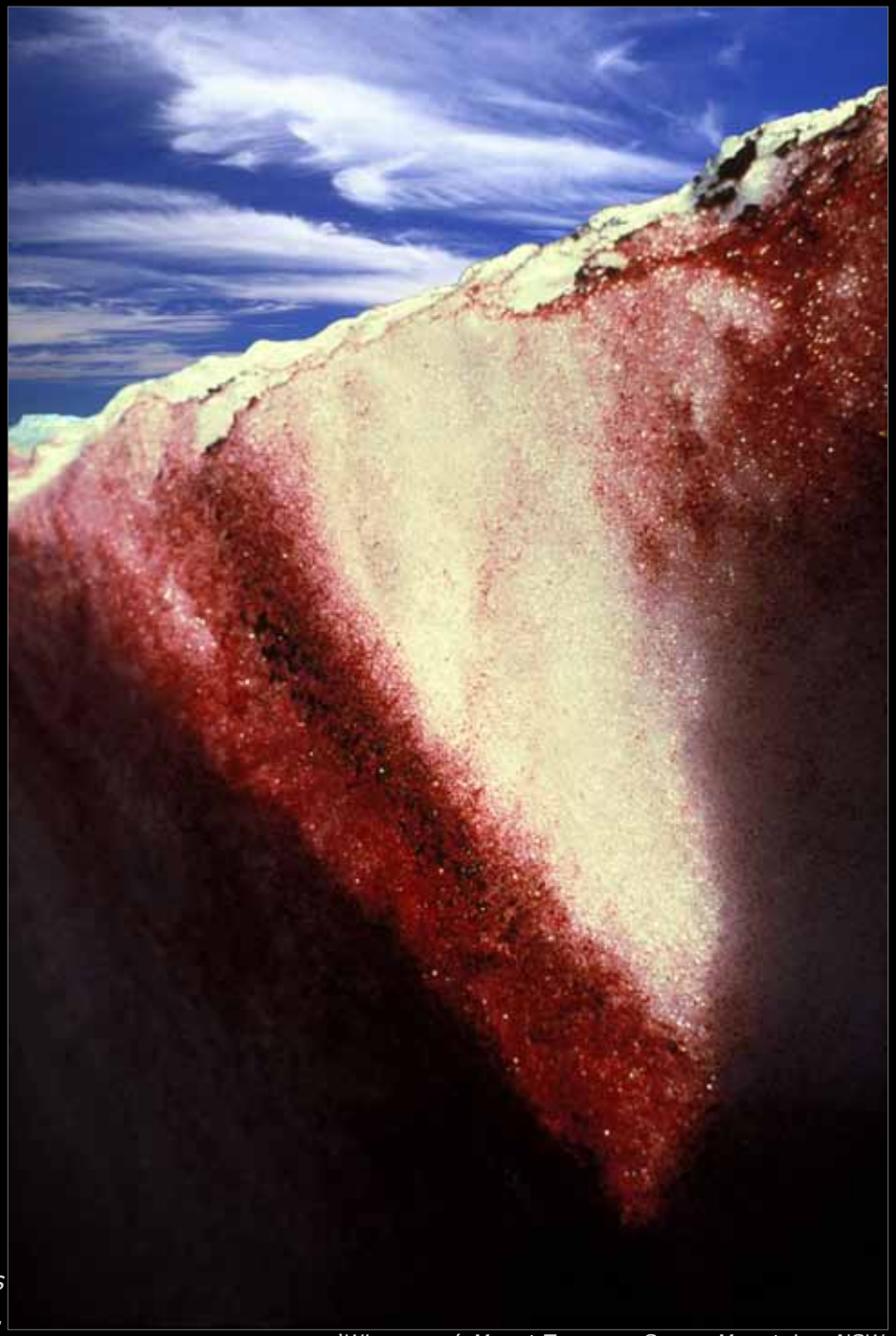
All life is bacterial.

All life is fractal.

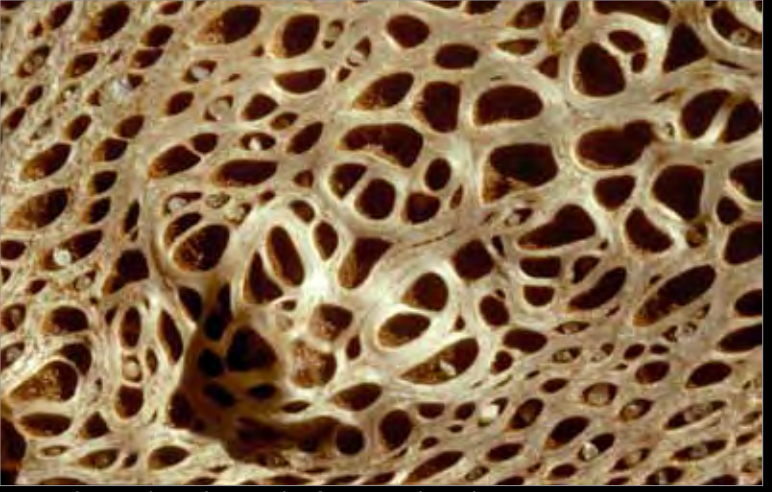
Finke River, NT.

ABOVE: The oxygen released by mats of photosynthetic algae in desert water-holes provides floatation that holds their cyanobacterial symbionts up to the sun.

RIGHT: The algae in 'wine snow' shield their cyanobacterial endosymbionts from UV damage by incorporating a heavy screen of red carotenoid pigments.



'Wine snow', Mount Twynam, Snowy Mountains, NSW.



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

FRACTAL FLORA

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.

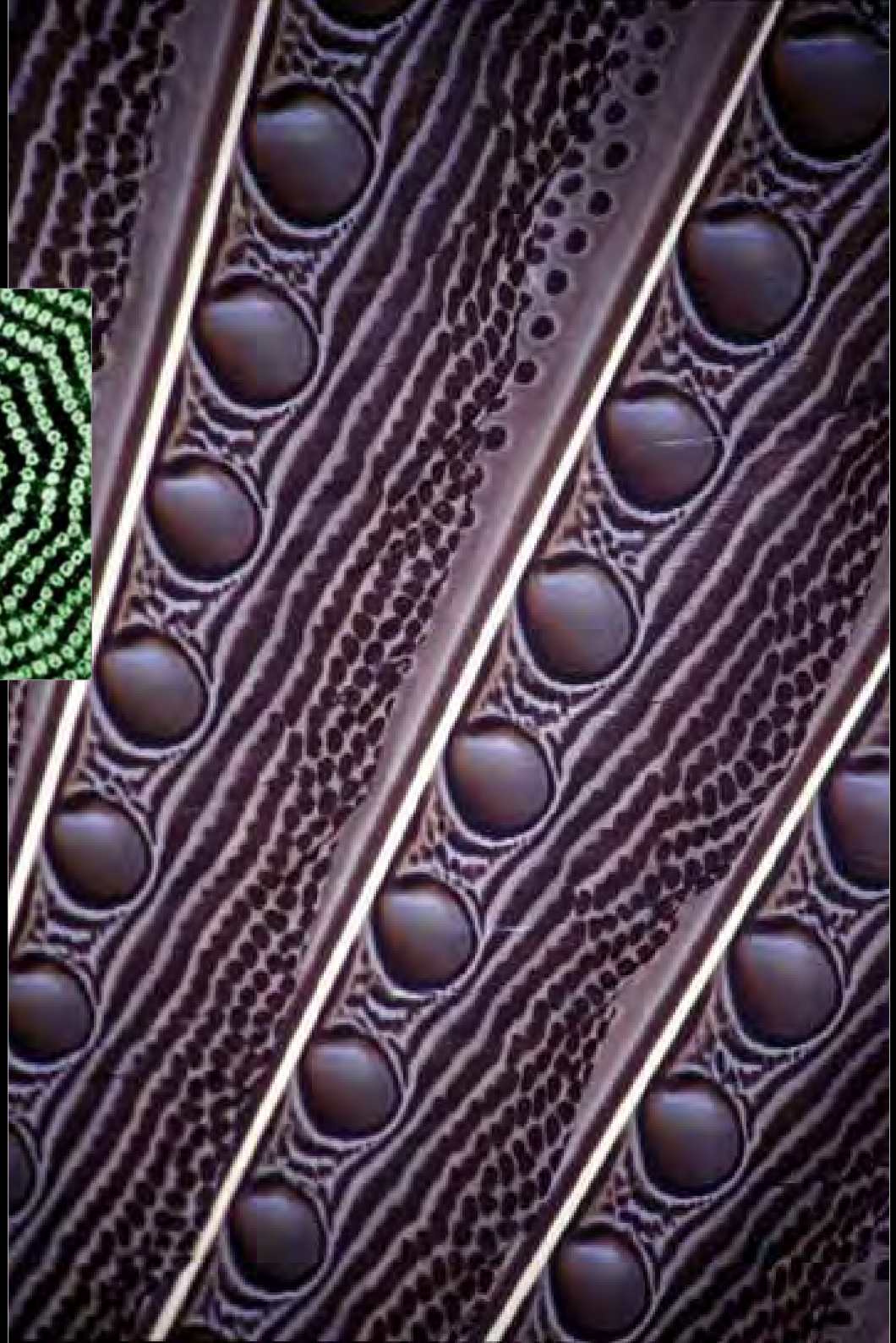
Gimlet gum, *Eucalyptus salubris,* WA.

FRACTAL FAUNA

Sea urchin shell, NSW.

Axopod microtubules 1

Human brain (Broca's area)

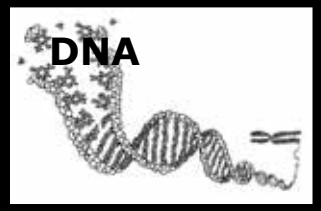


Wing feathers of an Argus pheasant (*Argusianus argus*).

HYDROGEN: LIFE'S MAKER Evolutionary milestones ...

Hydrogen's weak bonds keep water liquid between 0°C and 100°C and enable ice to float. (p7)

Thanks to the lopsided attachment of two hydrogen atoms to each oxygen atom, water molecules are slightly polarised and provide a universal solvent and a medium of transport for many of life's nutrients. If water behaved like other solvents and increased in density as it froze, ice would sink and the seas would freeze from the bottom upwards.



Hydrogen provides the weak molecular bonds that enable genetic material to replicate and yield protein. (p9)

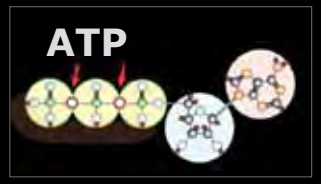
Hydrogen not only fires the stars and lights the universe, it performs a similar role in the moist microcosmos of the Earth's biosphere. As the smallest and most abundant element in the universe, hydrogen possesses only a single promiscuous electron and forges bonds that are about 5% as strong as other bonds. It is hydrogen's peculiar weakness that makes 'life' possible.

Hydrogen-loaded carbon chains form waterproof membranes that define biological structures. (p10)

The impermeable bilipid layers that form organic boundaries allow bacteria and their chimeric composites to preserve their fragile contents from external stress. These membranes also accommodate specialised channels that are able to regulate the intake of nutrient and discharge of waste products.

Hydrogen harvested from volcanic gases or from water molecules appears to have provided the basic energy source for the Earth's primordial biota. This remains true for the current biota. (p11)

Judging by life's primal and abiding hunger for hydrogen as its basic metabolic energy source, this smallest of atoms constitutes the elusive 'spark of life' that was so dilligently sought by philosophers and alchemists throughout history.



Hydrogen protons fuel the manufacture of ATP, the universal energy carrier for all organisms. (p13)

When some bacteria developed the ability to manufacture ATP and develop aerobic respiration, they tapped into a far richer source of metabolic energy than was available to their fermentative ancestors. ATP fuels all plant and animal cells.

Hydrogen harvested from water (photosynthesis) releases oxygen that pollutes the biosphere. (p15)

The evolution of chlorophyll-mediated photosynthesis, aided by ATP, polluted the biosphere with so much oxygen that some bacteria protected themselves by seeking refuge or collaborating, both internally and externally, thereby giving rise to eukaryotes (cells with nuclei). This launched the evolution of the modern world's oxygen consumers, including animals like us.

THIS COSMIC CAMELOT ...

THIS COSMIC CAMELOT

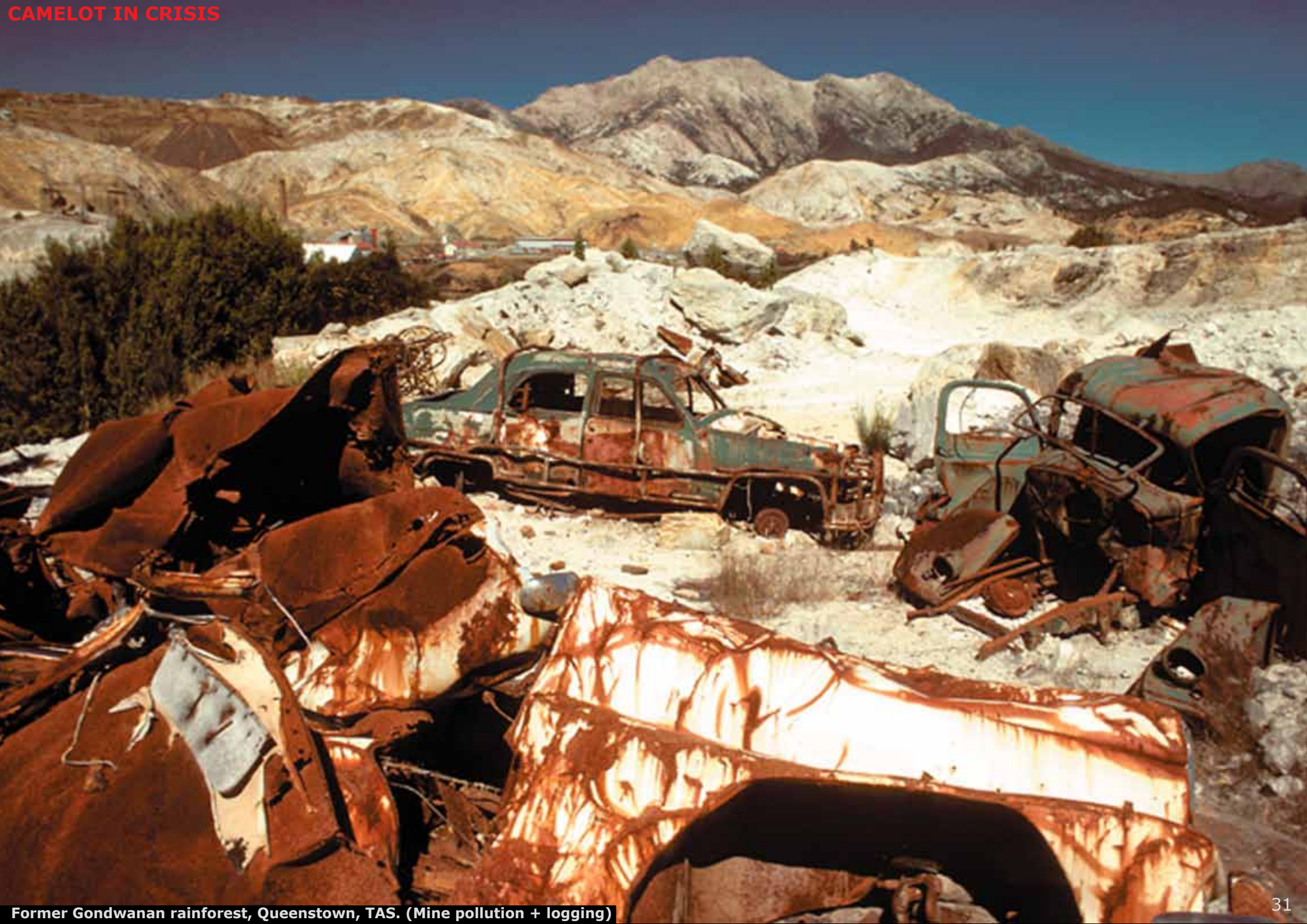
Earth's modern biota constitutes a gigantic air-conditioner. Its organisms cool the planet by pumping carbon from the atmosphere into their bodies, and from there into the soil, rocks and seas, where it may remain locked out of the carbon cycle for long periods of geological time. It is a process that began some four billion years ago when the Earth was young and its atmosphere contained more than 100 times the carbon it holds today. Inevitably, life seized on this abundant, stable building material and by thinning the atmosphere's heat-retentive carbon blanket it cooled the planet to its mild Phanerozoic range of 12°–20°C (current average ~16°C.)

Via this process, life's hydrogen-fuelled primary producers—photosynthetic bacteria—have created a moderate, oxygen-charged biosphere that nurtures a vast biota of other organisms.

This is the cosmic Camelot that we enjoy today.

PHOTO: Robert Simmon and Reto Stöckli, NASA.

Ancient Gondwanan rainforest, Cradle Mountain National Park, Tasmania.



Former Gondwanan rainforest, Queenstown, TAS. (Mine pollution + logging)

HUMANITY'S IMPACT ON THE BIOSPHERE:

IMPACT = Population x Affluence x Technology (I = PxAxT)[2]

POPULATION

12,000 years ago: ~ 5 – 6 million

Present time: ~7 billion
(growth rate: ~0.8% p.a.)

AFFLUENCE (economic consumption)

12,000 years ago (Tribal groups)
nomadic hunting and gathering

Present time (50% urban)
agricultural-industrial

TECHNOLOGY

12,000 years ago: fire
(sole energy source)

Present time: fossil hydrocarbons, hydro-electricity
nuclear fission, plus several 'renewable' sources.

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)

HUMAN IMPACT

12,000 ago — present time

POPULATION

(~ 5 million)

Last of the nomads, Jigalong, WA

About 7 billion
(growth: 0.8% a 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.

A SPECIES IN PLAGUE

The trouble began when a small population of large-brained primates discovered how to extract disproportionate energy (food and fuel) from their birth environment. They achieved this by planting seeds, domesticating their more docile prey and harnessing the energy in fire. Inevitably, the global population began to grow.

Aided by technology, food and fuel became abundant and population growth became exponential.

Exponential population growth is the definitive characteristic of a species in plague, and as a large omnivorous animal the impact of our plague on the biosphere soon became insupportable.

Inevitably, our global habitat began to wilt under the strain ...

POLLUTION: Moomba rubbish, Melbourne, VIC

DESERTIFICATION (water consumption NSW)

CONSUMPTION (NSW)

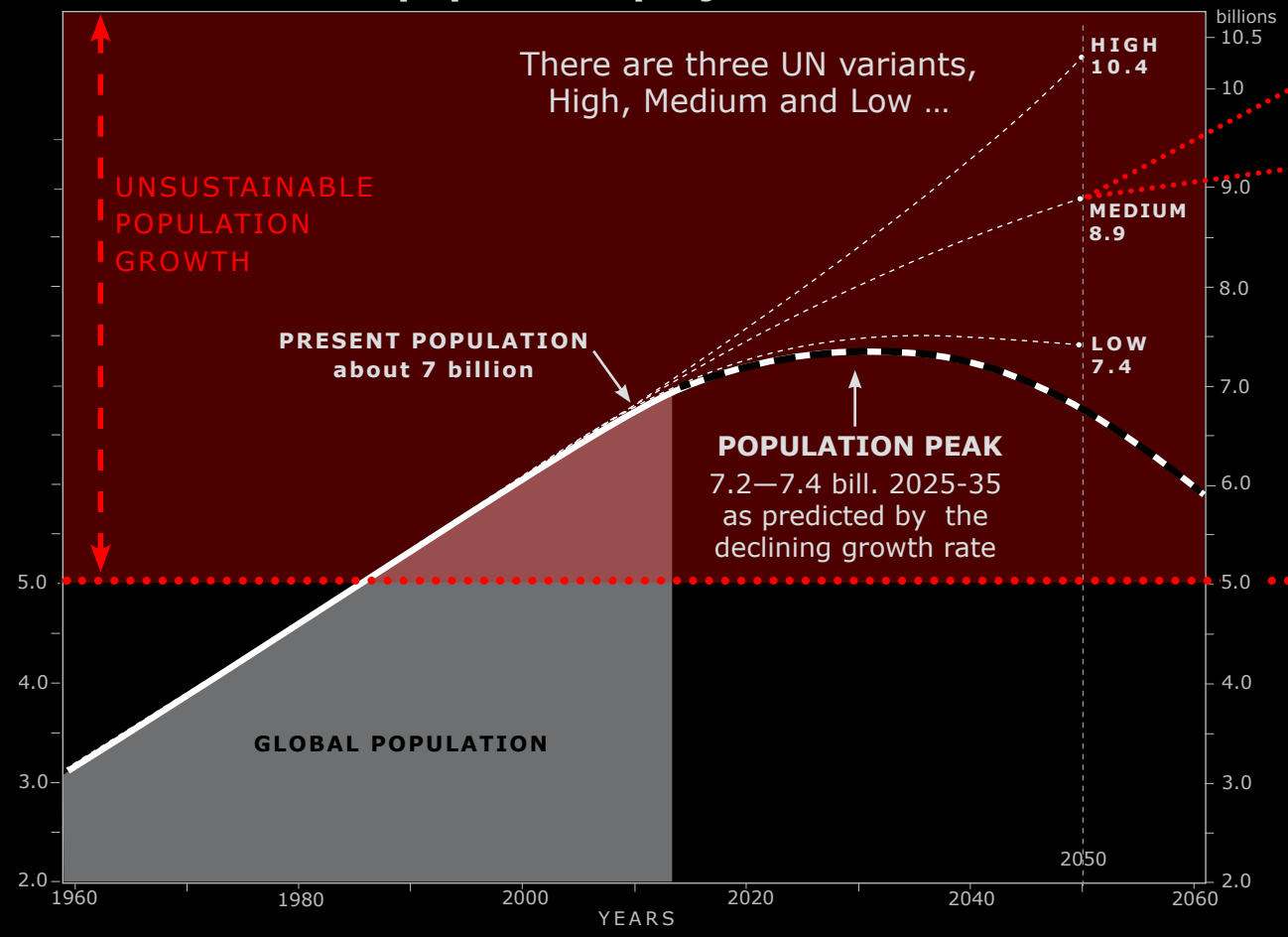
INDUSTRIAL POLLUTION (steel mills, NSW)

SALINATION (land clearing, VIC)

GLOBAL POPULATION GROWTH

Fact and forecasts

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 when the global population reached five billion. Any further growth was then certain to produce a resource collapse that would either cull our species or extinguish it from the planet's biota

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

See: *'The Population Debate'*

PLAGUE SPECIES: *Homo sapiens*

There are two ways to interpret the wide variation in the UN's three growth-rate projections. Which scenario we prefer to believe is entirely determined by whether we are anthropocentric or non-anthropocentric in our perception of humanity's place in the biota.

1. The ANTHROPOCENTRIC reader assumes that humans are essentially rational and that human reproduction is primarily determined by cultural factors. This results in the belief that fluctuations in the growth rate of the global population are produced by variation in the cultural mores that predominate as populations age and social-stress levels change. The education of women plays a major role in this.

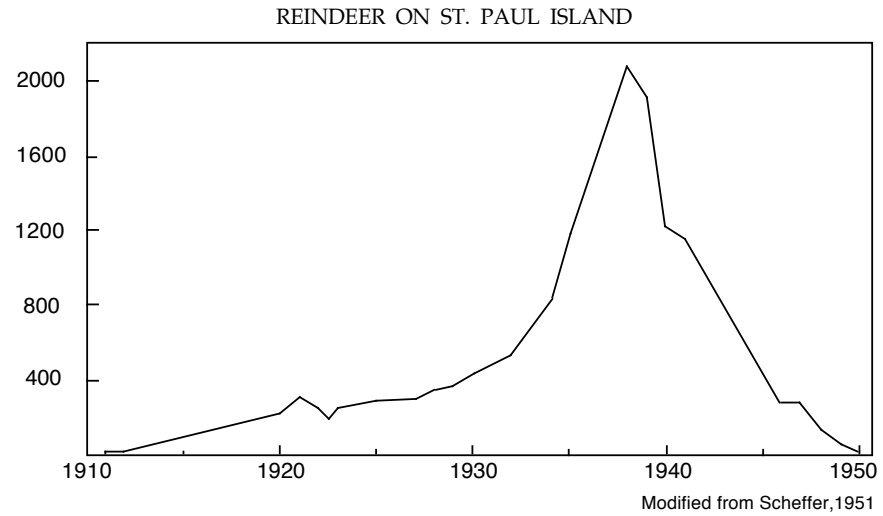
2. The NON-ANTHROPOCENTRIC reader assumes that human fecundity and culture are genetic artifacts (as in other animals). Both therefore fluctuate automatically in response to fluctuations in the availability of food (as in other animals), and to changes in their social and physical environment.

Since all the biological evidence indicates that this latter view is more accurate, we cannot then avoid the conclusion that our exponential population growth during the first six decades of last century signalled that our species was in plague.

All plagues end in similar fashion, with a population collapse that mirrors their exponential growth. If this failed to occur, a few highly versatile species might proliferate indefinitely, endangering large segments of the biota and putting the evolutionary process at risk.

This does not happen, however, because prolonged exponential population growth by any species invariably triggers a complex backlash of biological and environmental factors that ends the species plague phase and replaces it with an equally precipitous collapse phase.

This plague cycle is a pattern that appears to characterise all life and probably represents a genetically orchestrated mechanism that helps to preserve the biota and has therefore become embedded in the evolutionary process via Darwinian selection.



Reindeer were introduced to St. Paul in the Bering Sea in 1911. The island's 106 square kilometres (41 square miles) was an undisturbed environment that was free from major predators. By 1938 the initial herd of 4 males and 21 females had grown to about 2,000 animals. They severely overgrazed their habitat and by 1950 the herd had collapsed to just 8 animals.

*See: '**Plague Species** ...Is it in our Genes?' / '**The spirit in the Gene**'*

HANS SELYE'S GENERAL ADAPTATION SYNDROME (GAS)*

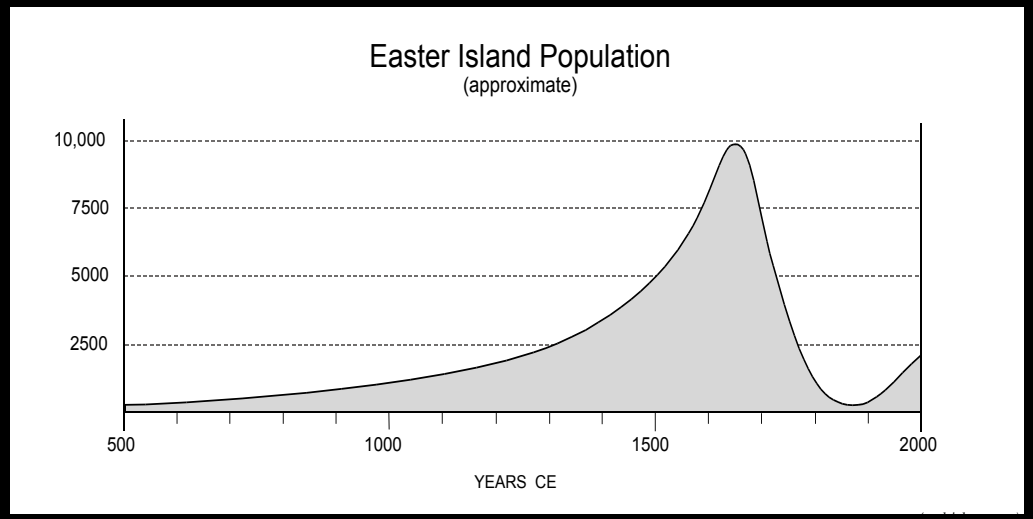
When populations grow exponentially social stress levels rise. This results in a predictable spectrum of physiological and behavioural responses that invariably reduce the offending population's fertility rate below replacement level. A Canadian endocrinologist, Hans Selye, first identified these auto-responses in rodents about 1936. He collectively named them the General Adaptation Syndrome (GAS). Many other studies have since corroborated Selye's findings.

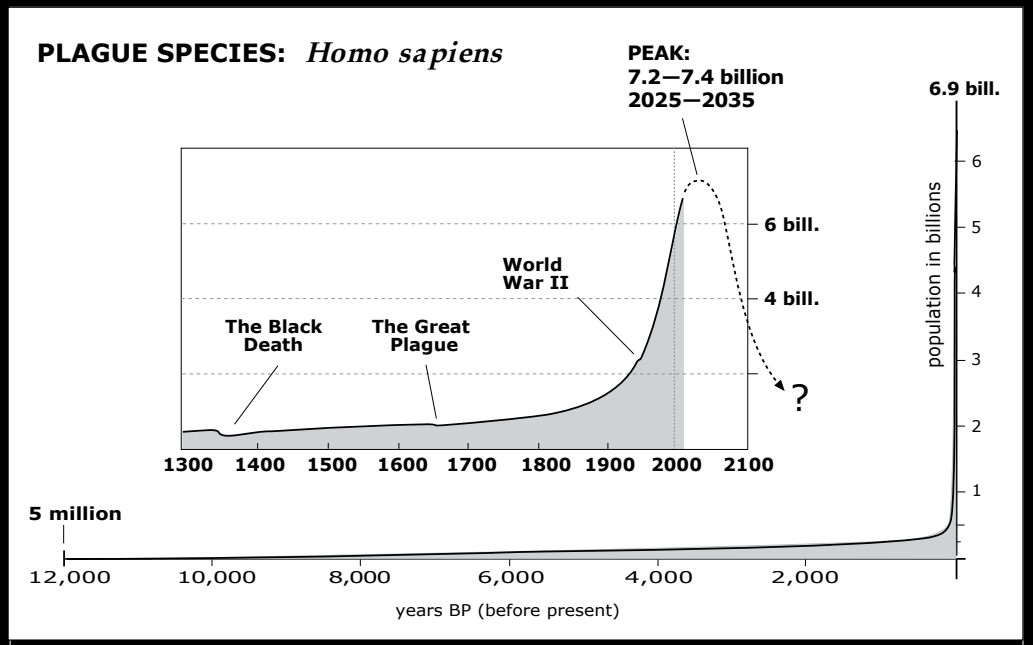
A GAS decline typically appears well before famine and disease begin to cull the population, and its hormonal 'fingerprint' often persists in wild mouse populations long after the population has shrunk to pre-plague levels and the habitat has recovered. The GAS has led to the local extinction of a species in some instances.

Symptoms of the GAS in mammals include curtailed reproduction, increased abandonment of unweaned offspring, and an increase in dysfunctional and genetically unproductive sexual behaviour. Paedophilia, homosexuality, and inappropriate sexual display produce few offspring, and inadequate parenting tends to produce higher levels of aggression, incompetence and suicide in those offspring.

These patterns often coincide with physiological malfunctions such as inhibited sexual maturation, diminished ovulation and implantation, inadequate lactation, glandular malfunctions, increased susceptibility to disease and a sharp rise in infant mortality.[3]

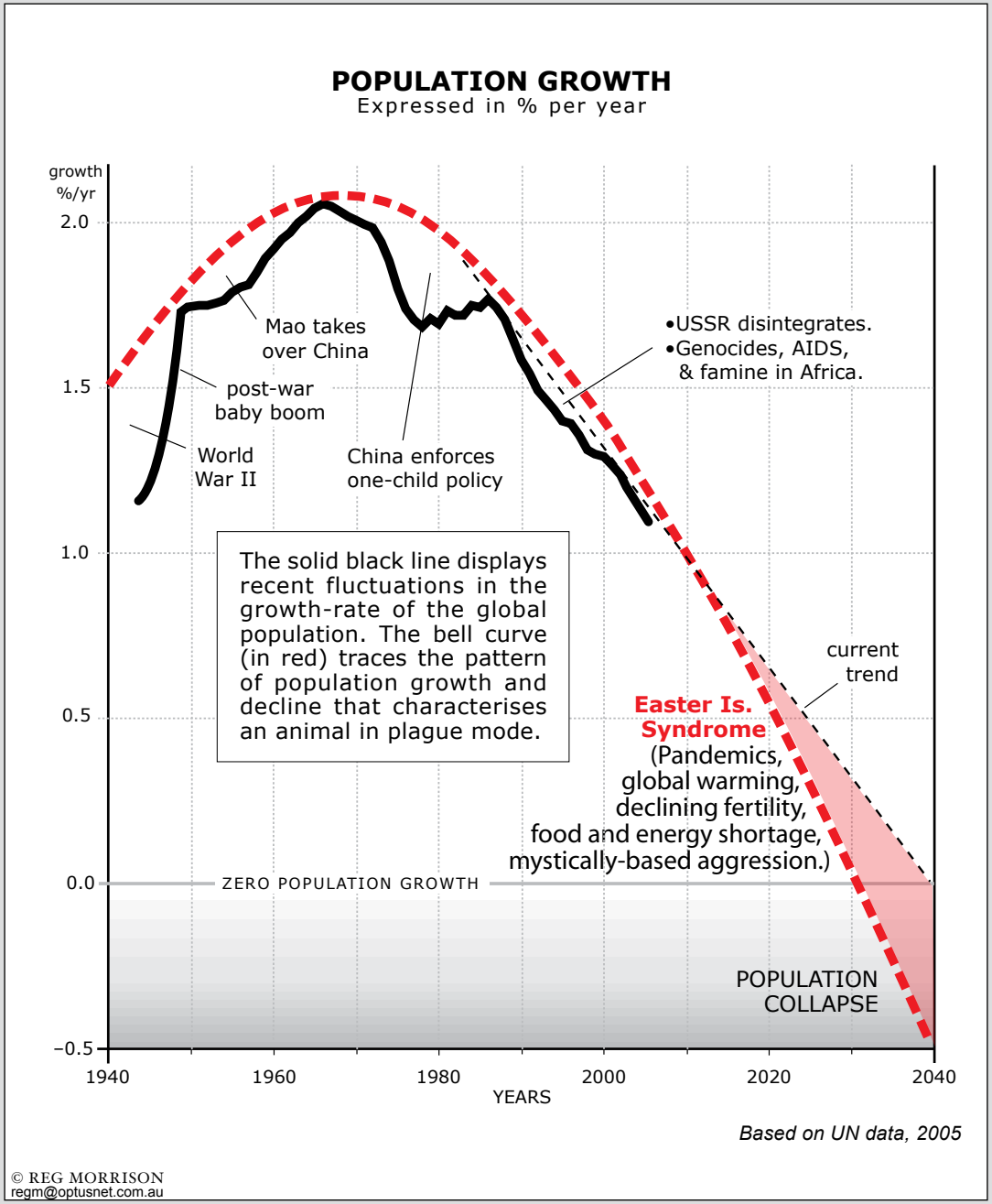
The collapse of the Easter Island civilisation during the 18th and 19th centuries typified evolution's plague syndrome in its human form. It began with Selye's GAS and ended in a frenzy of starvation, aggression and disease—a typically Malthusian conclusion.





ABOVE: The current collapse in global fecundity promises to fulfil the standard graph of a mammal plague, with a collapse rate that matches its exponential growth rate.

*See Appendix 4 (General Adaptation Syndrome)



THE 'UNACCOUNTABLE' GRAPH

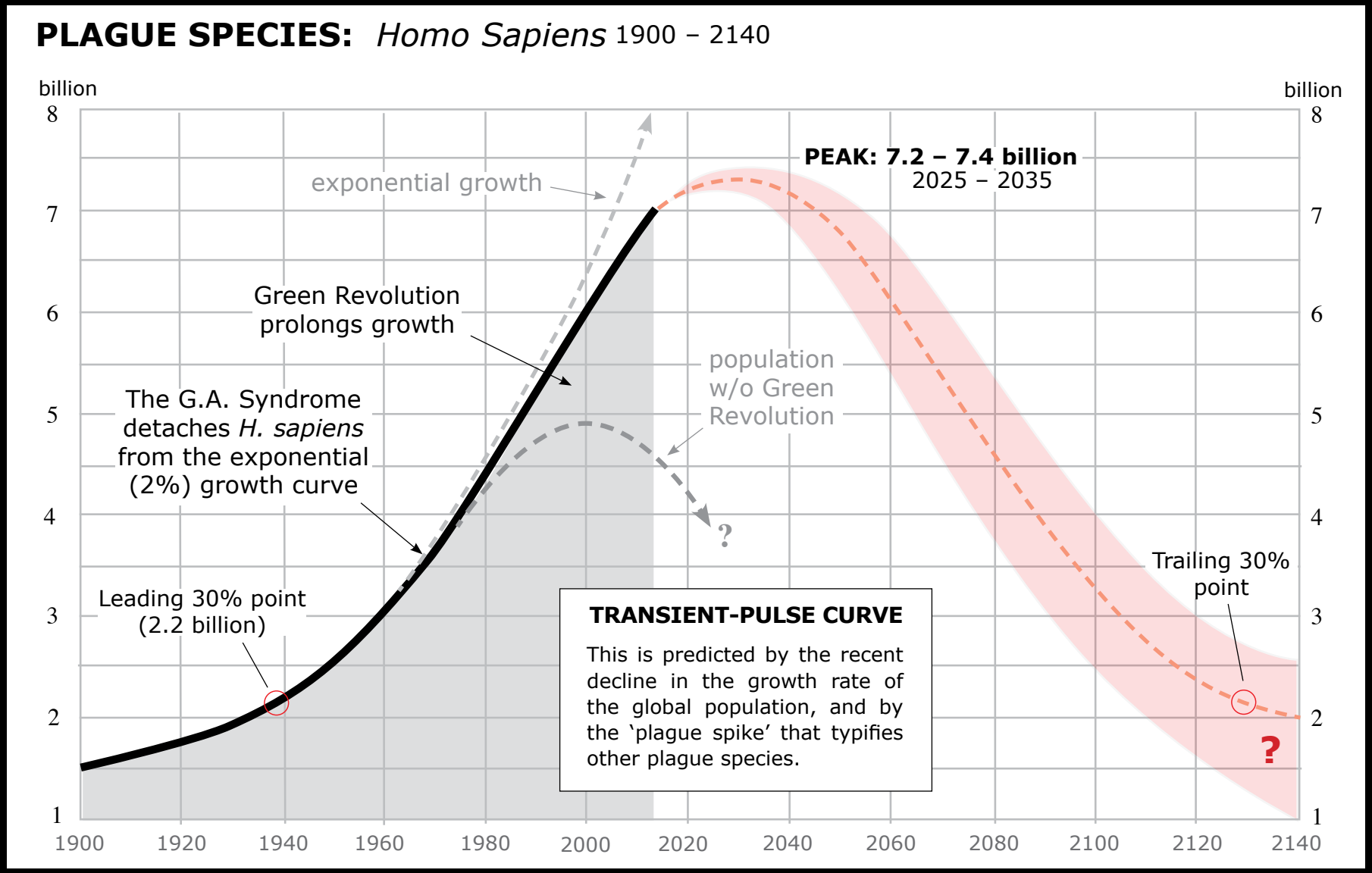
This graph is based on annual growth-rate figures that the UN's Population Division used to publish until 2003. Perturbed perhaps, by the abrupt decline that appeared during the 1970s and then reappeared in the 1990s, UN demographers subsequently published only five-year 'forecasts' of global population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

The initial collapse in the growth rate that first appeared between 1967 and 1978 was generally attributed to the introduction of China's 'One-child' policy. But when a very similar decline reappeared in the 1990s the global nature of this phenomenon became impossible to ignore. It was described as 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 is likely to continue. There has been no other global fecundity decline of this magnitude since civilization began, and yet, amid the clamour of cultural explanations, the evolutionary significance of this ominous global trend has been universally ignored.

NOTE: The basic shape of the black line shown in this graph was verified by UN demographers in 2003. 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' unprecedented fecundity decline.**

*See: '*The Population Debate*'



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.

OUR FREE RIDE IS OVER*

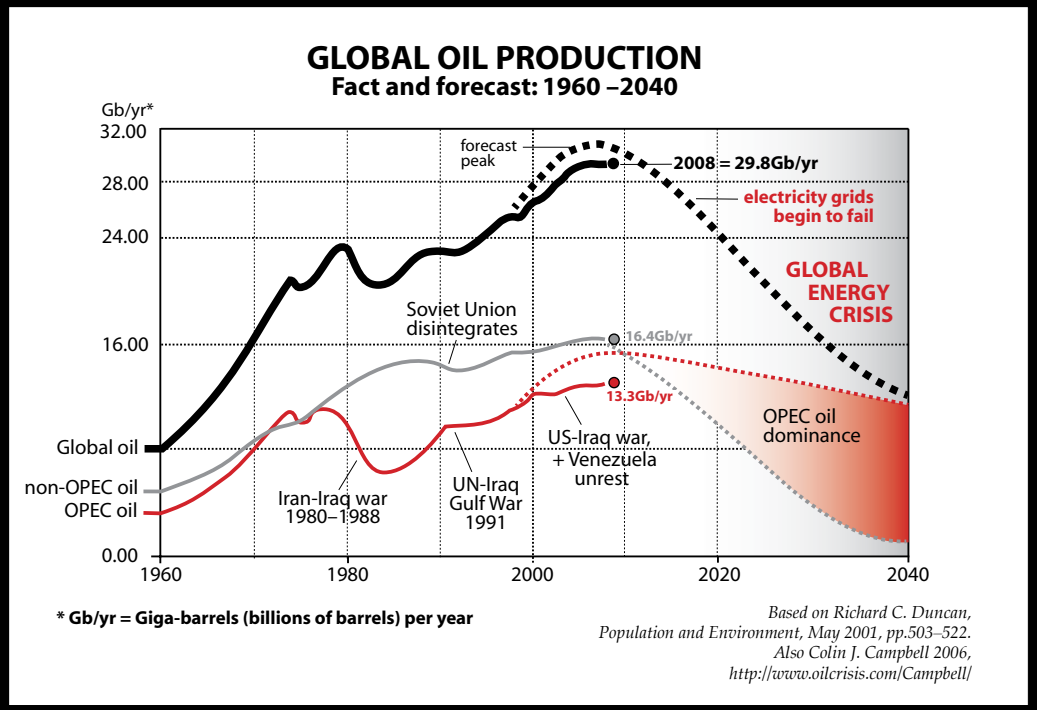
In view of hydrogen's role as the primary energy carrier throughout the cosmos and its consequent role as the maker and breaker of life, it now seems likely that our civilisation's extreme dependence on the three fossil hydrocarbons, coal, oil and gas has placed our species on evolution's endangered list. The most crucial of those three fossil fuels is oil. Not only is it the easiest to extract, transport and burn, it is by far the most energy-rich because of its hydrogen content. The more hydrogen an oil contains, the more calories each litre yields when it is burnt.

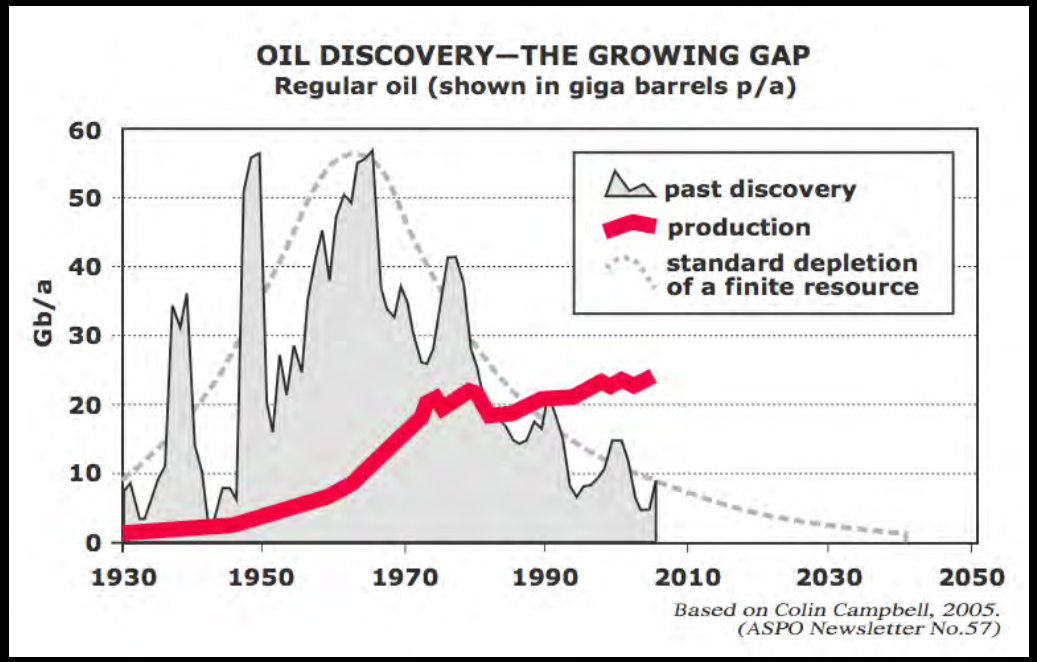
Luckily for us, the world had large natural reserves of oil, and it has been relatively cheap to extract. But the pump price gives no hint of the real cost of the multitude of petroleum products that civilisation consumes each day.

For example, each litre of petrol that we burn in our cars is the distilled residue of some 23 tonnes of ancient organisms (generally phytoplankton). Meanwhile, the volume of oil products consumed by modern civilisation in a single day originally cost the planet some 13 months of continuous photosynthesis to produce.[4]

It is an economically viable fuel because the planet has already done most of the preliminary distillation work. No other energy sources, finite or renewable, can possibly compete with it for this reason.

Thanks to the Earth's generous reserves of oil, humanity has had a relatively free ride into the twenty-first century, but oil production peaked in 2005 and is now about to decline. Meanwhile, our technology-based culture is so dependent on oil that it takes some 10 calories of petroleum to deliver each calorie of food that we eat.





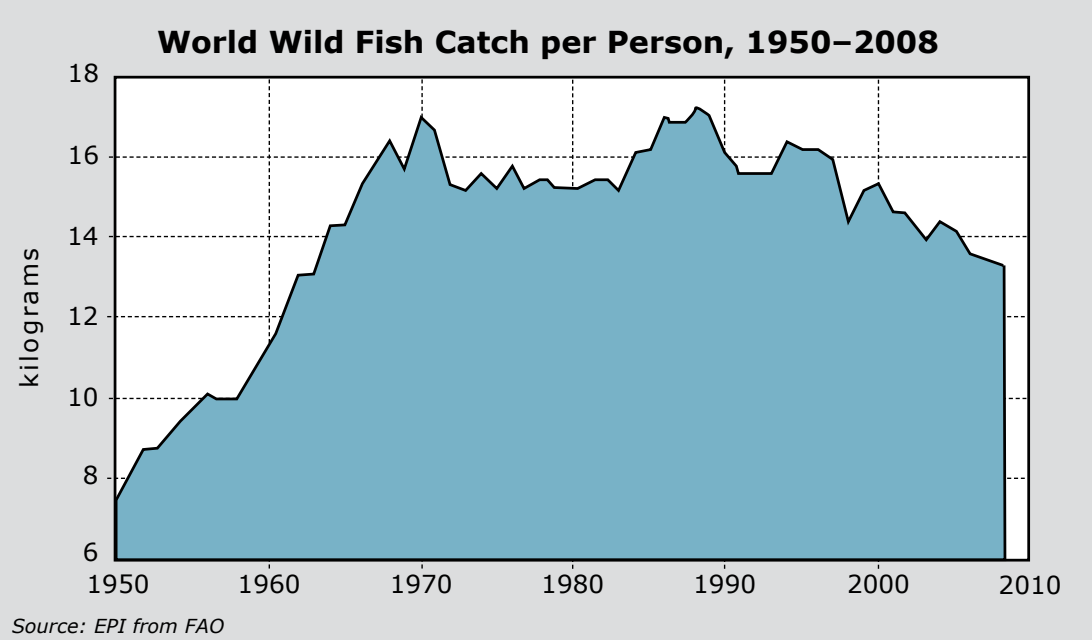
* See Appendix 5 ('Peak Oil')

The marine harvest

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 collapsed, and 'Fishing down the food chain' is now standard practice. And because of the increased effort and technology required to fulfil their quotas, fisheries now account for about 1.2 percent of global oil consumption. According to '*Ambio*', a journal of the Swedish Academy of Sciences, the fishing industry generally consumes about 12.5 times as much energy as the fish provide to those who eat them.

Aquaculture meanwhile conceals the growing shortfall in the wild harvest, and farmed fish now constitute almost a half of the seafood eaten each year around the world. This means that aquaculture is the marine equivalent of agriculture's Green Revolution. And its penalty is similarly concealed. Rarely mentioned is the fact that predatory farmed fish gobble anything from two to six times their own weight in fishmeal that is largely made from a multitude of non-commercial wild species. Aquaculture is consequently a massive consumer of wild marine fish, and contributes to the global marine devastation as well as to our species' increasing energy debt.



Source: EPI from FAO

Thanks for all the fish, but what about the krill?

As the world's major fisheries gradually buckle under the onslaught of commercial fishing, the foundation of the planet's marine biota is also showing signs of strain. Krill numbers have dropped by up to 80% in some polar regions since the 1970s, and severe food stress has appeared in many penguin and seabird populations.

Krill are small shrimp-like crustaceans that essentially feed on the photosynthetic algae that live beneath the sea ice. As krill-food, the algae not only support the rest of the polar biota, they help to oxygenate the seas and thereby, the atmosphere that we breathe. Their waste gas (DMS) also contributes to the formation of rainclouds.

When the sea ice shrinks, the algae disappear and krill decline. As krill decline, so does the marine biota, and so on up the food chain. [5]

The grain harvest

Although a final accounting is not yet possible, early reports suggest that grain harvests across Russia, Canada and the Indian subcontinent have suffered their worst decline in many decades due to extreme heat, drought, wildfires and floods during 2009–10.

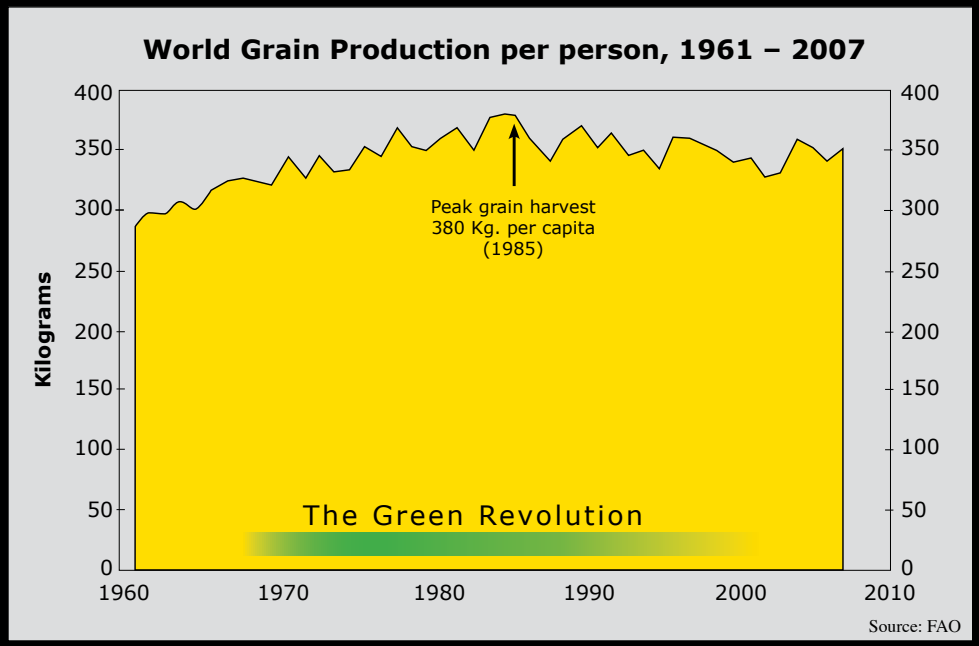
In the worst of these environmental traumas, Russian wheat production slumped by about a third and all grain exports were stopped by Kremlin decree; Canada's wheat production is expected to fall by 20%, and Pakistan's massive floods have submerged vast areas of the Indus valley, Pakistan's most fertile and productive region.

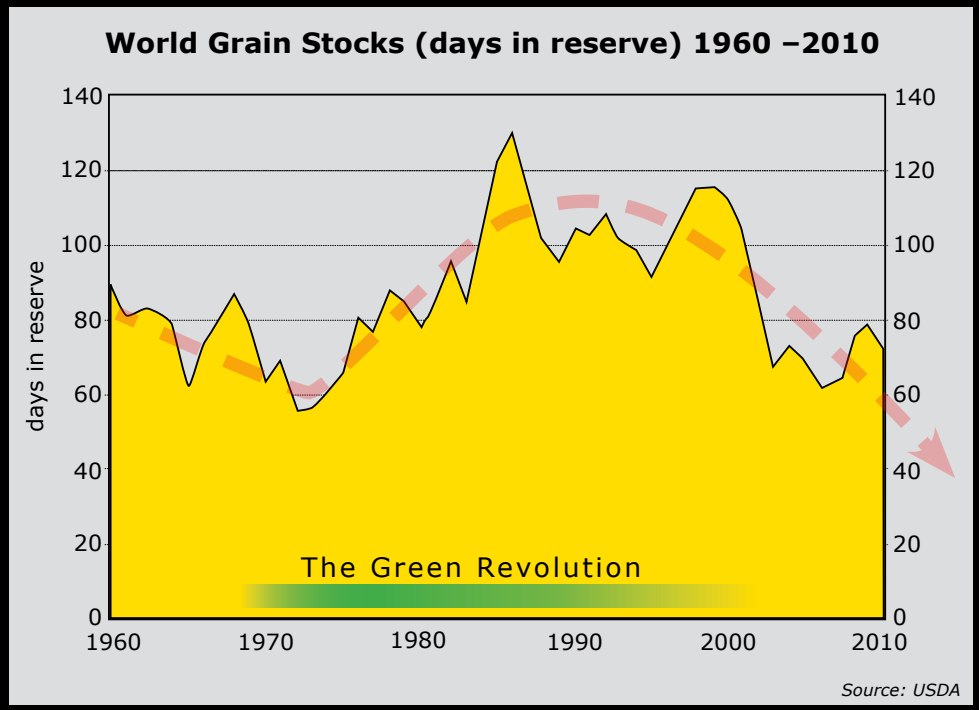
It now seems likely that the global per-capita grain production for 2010 will plunge to a level that guarantees widespread starvation in many parts of the dependent world for the next two years at least. In other words, the bottom has fallen out of the world's bread basket, meanwhile the global population has grown to almost 6.9 billion people.

The coincidence of these two events means that 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'. But the global population is now twice the size.

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 another 40 years it may have sealed our 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. ...





EVOLUTION'S HIDDEN PENALTY *

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—in accordance with Malthus' population proposition. Technology appeared to have saved us once again.

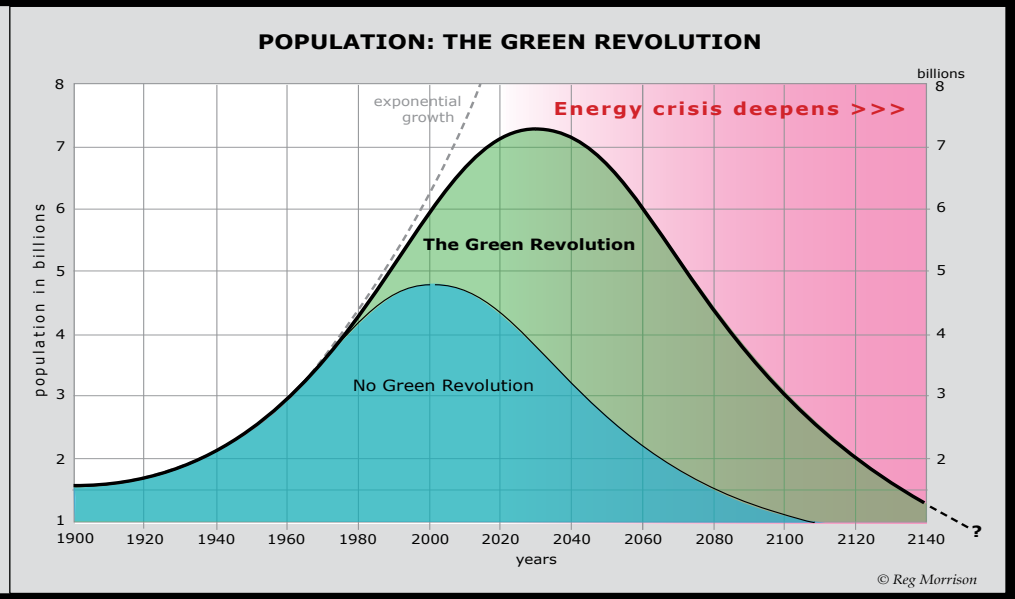
Cosmic laws determine that energy can neither be created nor destroyed, so 'high yield' is just a euphemism for 'high cost'. Inevitably then, the high per-capita harvests of the 1980s gradually disappeared in the 1990s as soil fertility shrank, fertilizer responses declined, and the population continued 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 concealed cost

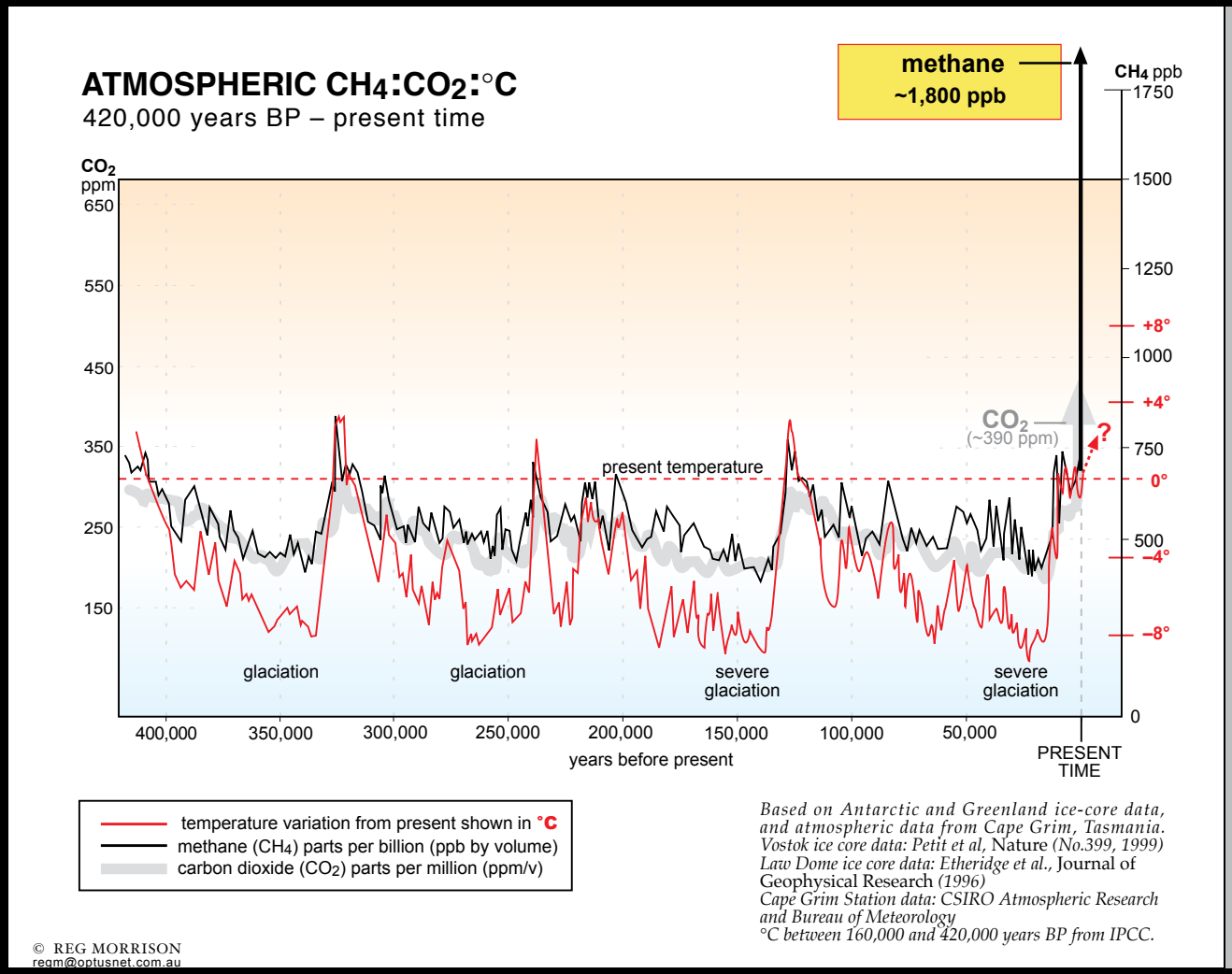
This graph reveals the Faustian face of human technology. All of the advantages it appears to offer are invariably outweighed by its hidden costs. Technology takes its 'pound of flesh' in the form of energy loss at some other place or at some later time, or via what is known as Jevon's Paradox.* It means that technology is never the panacea that it seems, and given time, it inevitably incurs a disproportionate cost, one way or another.

These are the inviolable rules of existence in a thermodynamic universe where energy only dissipates.



*See Appendix 3 ('Faustian Bargain')

Energy harvested from the environment in the form of food and fuel invariably exacts a fee that is directly proportional.



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. Both are now at their highest levels in recent time.

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.

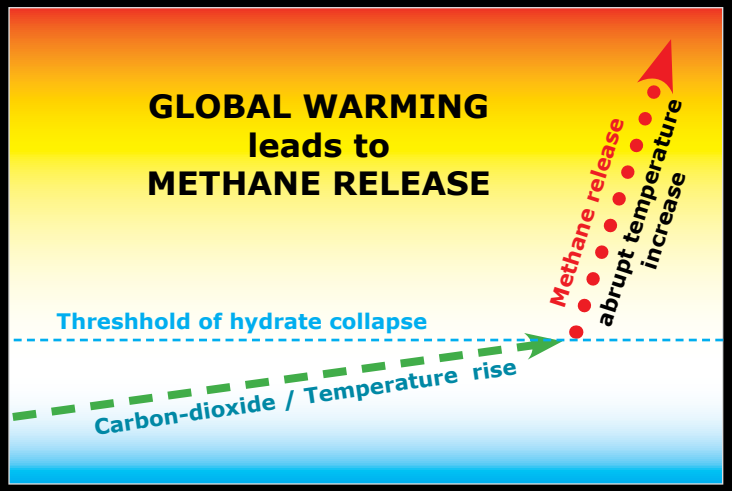
Atmospheric carbon dioxide has risen 36% during the past 150 years, but during that time the level of atmospheric methane has more than doubled. It is now at its highest level in 400,000 years. The above graph shows the tight correlation between temperature spikes and the methane spikes. This suggests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

METHANE RELEASE

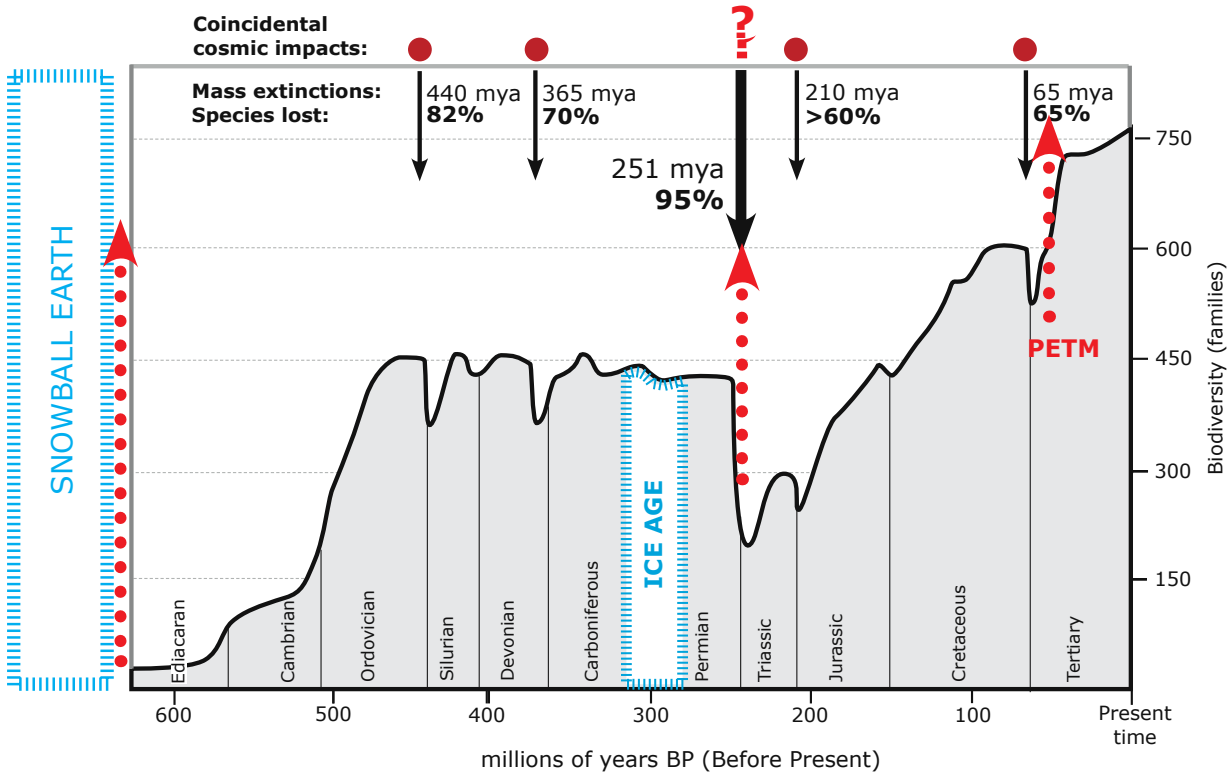
The massive reserves of bacterial methane that become trapped in marine and tundra ices for long periods of geological time may well represent the ultimate climate-control mechanism for the whole planet.

There is good geological and biological evidence to suggest that there have been three or four occasions in the past when eruptions of methane into the atmosphere have sent global temperatures soaring upwards. On each of these occasions the geological and fossil record indicates an increase in atmospheric CO_2 and a slow temperature rise, followed by an abrupt warming that can only be accounted for by a massive release of methane.

Ominously, each of these methane eruptions also coincides with a mass extinction of life.



MASS EXTINCTIONS : COSMIC IMPACTS : METHANE



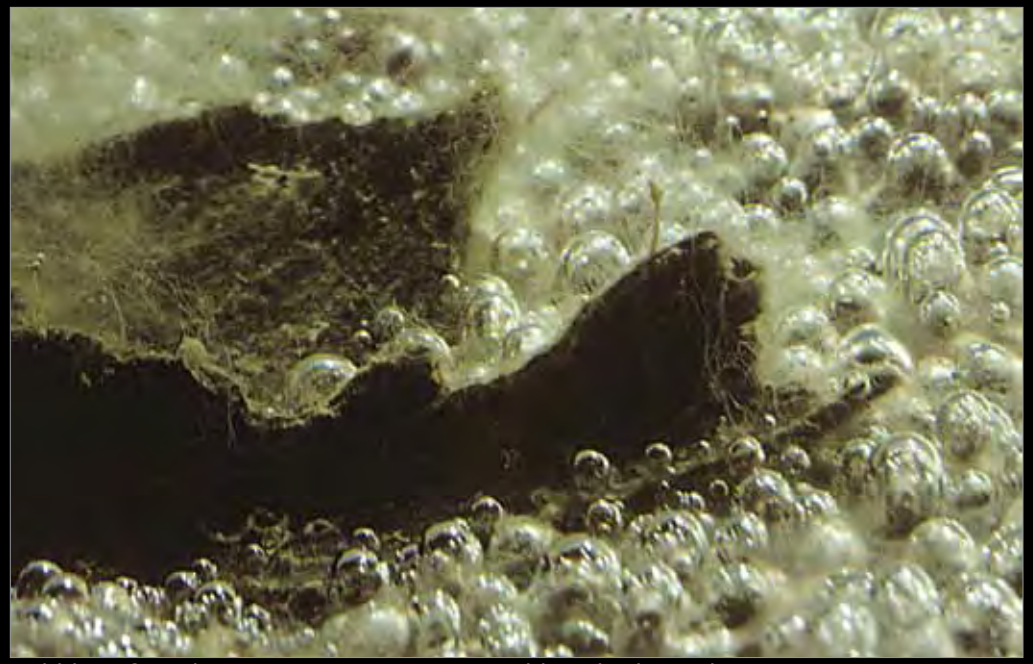
The two-stage sequence consisting of a long, slow temperature rise followed by abrupt global warming has been clearly identified on at least three occasions in the past. By far the most spectacular of these was the two-stage warming event that ended the world's greatest Ice Age around 630 million years ago. It ended more than 100 million years of global deep freeze, a time known as 'Snowball Earth'.

The second major methane release came around 251 million years ago when the massive forests that characterised the Permian period lay rotting in the deepening swamps of the world. It coincided with the greatest mass extinction of life in the fossil record. A smaller methane release occurred about 55 million years ago during a lethal warming event known as the Palaeocene-Eocene Thermal Maximum (PETM).

METHANE: extinction agent

Methane appears to have been a major factor in at least four of the world's great extinction events—around 630 million years ago, then at 260 and 252 million years ago, and most recently, 55 million years ago. On each of these occasions the atmosphere's CO_2 rose slowly, and then the world warmed abruptly. Only a massive injection of methane (CH_4) can account for such an abrupt temperature change. In the second-last event (252mya) methane appears to have been implicated in the disappearance of most of the world's surface life.

More than 20% of the world's methane emissions are natural and come from hydrogen-hungry archaebacteria that inhabit the Earth's crust to a depth of almost 4 kilometres. They are known as methanogens. The other 60% are attributable to human activity ...



Bubbles of methane carpet a stagnant pool beside the Finke River, NT.

Kow Swamp, VIC.

*LEFT & BELOW: Methane-generating archaebacteria discharge large volumes of the gas as they digest cellulose in anoxic environments such as swamps, flood-irrigated fields, stagnant waterholes, dams and reservoirs. The ancient forests of Redgums (*Eucalyptus camaldulensis*) shown here were drowned by waters impounded for irrigation purposes in the Murray valley, VIC. Decaying forests like these will yield hundreds of tonnes of methane for many decades to come as the trees fall into the water and become food for methanogenic bacteria.*

Lake Mulwala, VIC.

Human-generated Methane sources

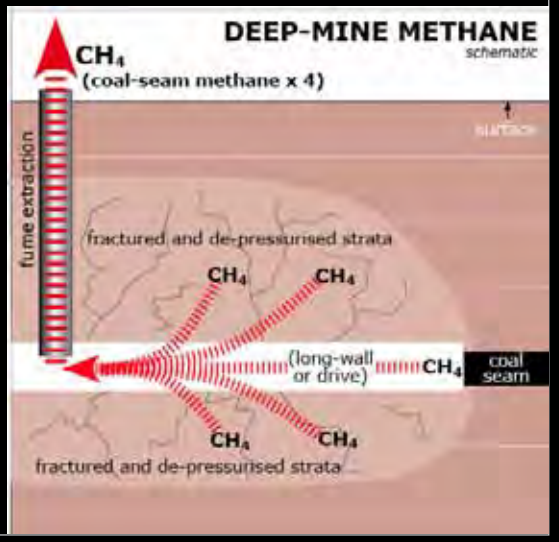
More than 60% of the daily methane emissions around the globe are directly attributable to human activity. The main sources are our vast herds of cattle and sheep (22%), the bacterial decay of manure and other liquid waste (14%), and swamp gas generated by flood irrigation, notably rice and cotton (more than 18%). In similar fashion, some hydroelectricity reservoirs release so much methane from rotting vegetation in their sediments that their greenhouse impact is greater than that of a coal-fired power station of comparable electricity output.

The mining of fossil hydrocarbons (coal, oil, gas) also releases a huge volume of bacterial methane into the atmosphere. ...

Beef cattle at an artesian bore, NT

Flooding of the Hebe coalmine, Collie, WA (1965).

*Most coal-mine methane is discharged by the coal-eating bacteria that infest the seam wherever water is present. Some Australian coals are up to 67% water by volume. Drilling and blasting during the coal-mining process initiates an extensive pattern of fractures in the surrounding strata, thereby releasing most of the methane trapped in the country rock. The evacuated air often contains four times the methane in the coal seam itself.**



* See also: *'The Clean-Coal Delusion'*

'Fracking' for gas

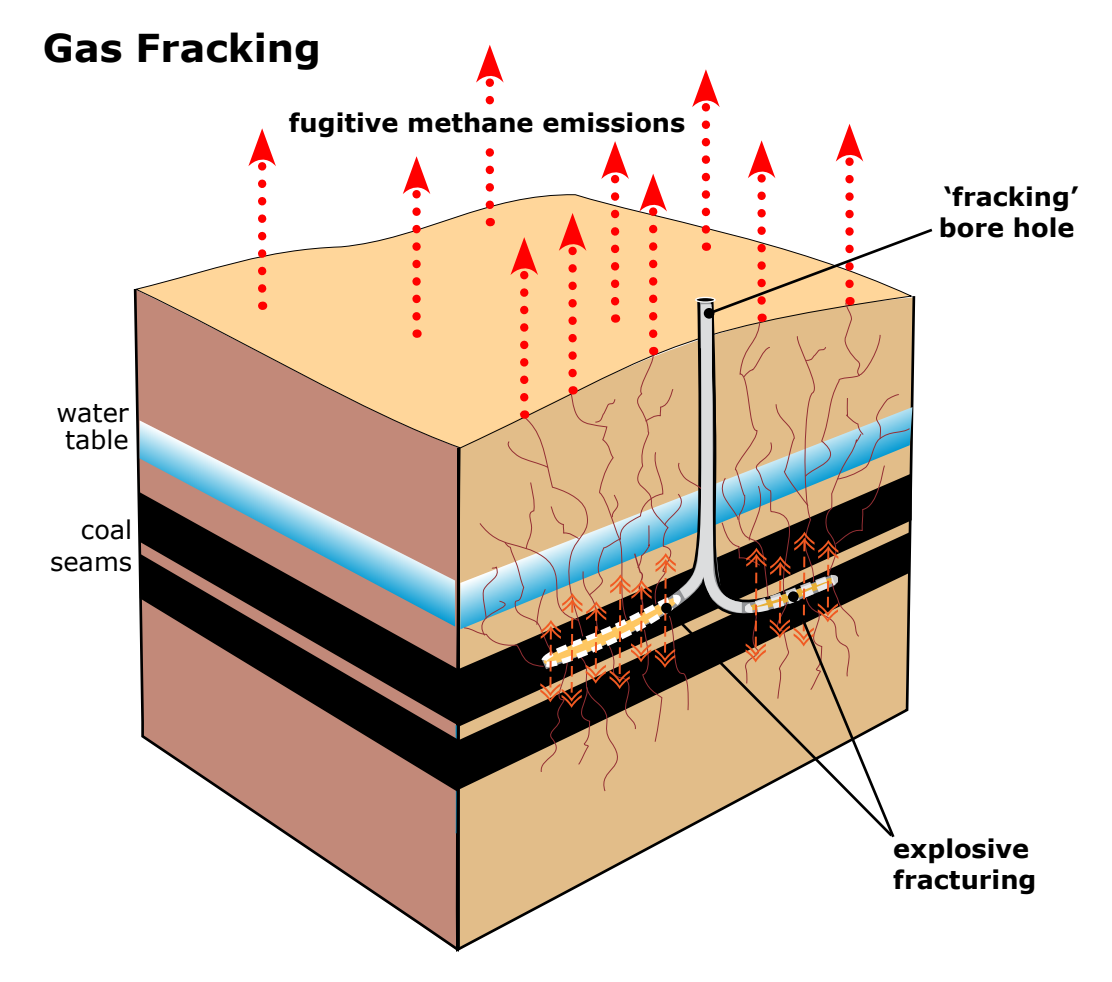
The primary intent of 'fracking' (hydraulic fracturing) is to open a multitude of cracks in the surrounding strata in order to release bacterial methane that has been accumulating in the country rock over hundreds of thousands, and perhaps millions of years. (Methane lasts indefinitely in anoxic interstitial environments.)

Since gravitational pressure increases with depth, the shallower the rock strata, the more easily it fractures. So fractures that begin at a coal-seam drill site invariably extend upwards much more easily than do those fractures that extend downwards.

This virtually guarantees that any blast designed to fracture the strata surrounding a coal seam will open a filigree of fine cracks throughout the region, some of which will extend all the way to the surface.

This extensive fracturing guarantees that methane and a variety of fracking chemicals will leak into any water table that overlies the coal seam, and also guarantees that methane will continue to leak into the atmosphere from small surface fractures on a semi-permanent basis.

When commercial interest in the gas field ceases, for whatever reason, maintenance of the the metal and concrete installations will cease and they will gradually disintegrate. This will enable an increasing leakage of methane from the boreholes . . .



"Fracking" is the technique of pumping a mixture of water, sand and a cocktail of toxic chemicals under pressure into horizontally drilled wells in order to liberate the gas from coal seams and shale. But fracking extracts only 20 per cent of the gas, a figure confirmed by Canada's National Energy Board. The rock formations shattered by fracking will allow the remaining 80 per cent of shale gas to continue bubbling into the groundwater and into the atmosphere through the fracture system and the disused and disintegrating wellhead fittings. *

*Marc Durand, former Professor of Hydrogeology, L'Université du Québec à Montréal (UQAM).

EVOLUTION'S PENALTY CLAUSE

• ***Energy only dissipates***

(second law of thermodynamics)

All energy gains are short-term and conceal disproportionate energy debt in the long-term

• As the world's oil reserves begin to shrink and concern over CO_2 emissions from coal-burning grows, our increasing hunger for energy is switching commercial attention to the extraction of methane (CH_4).

The rush to drill explosively into coal seams and gas-bearing shales has begun to open billions of new methane leaks from the hundreds of thousands of new gas wells that are being tapped on all continents.

Recent research from one US gas field shows that fugitive emissions ***from each well site*** commonly averages around 4% of the total volume of the extracted gas. This peer-reviewed study, published in *Nature,* warns that this figure does NOT include additional losses from the pipeline and distribution system. This new assessment is more than double the official inventory figure. *

• With atmospheric methane already at an all-time high and accelerating upwards due to the melting of marine hydrates and tundra permafrost, it seems that evolution's Faust clause is being invoked yet again, as evolution collects its energy debt via runaway global warming and catastrophic sea level rise.

* http://www.nature.com/news/air-sampling-reveals-high-emissions-from-gas-field-1.9982

Methane hydrates

Methane discharged by the vast mass of bacteria that inhabit the Earth's crust tends to accumulate in the upper layers of the seabed wherever porous marine sediments happen to freeze. The ice in these layers forms a dense, interlocked lattice of crystals that traps the bubbles of methane and prevents their escape into the atmosphere.

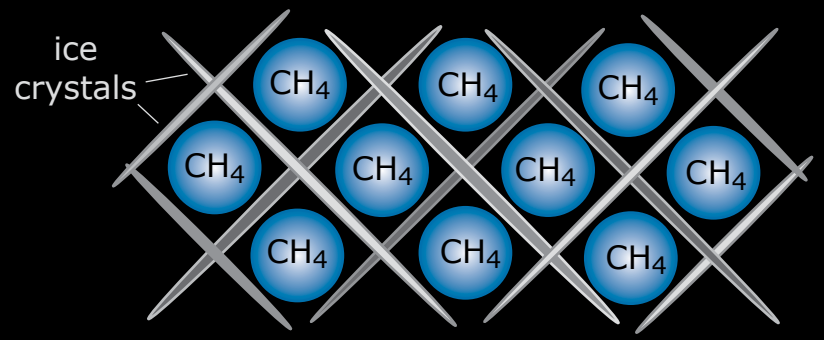
These huge methane reservoirs are continuously recharged by the decay of biological material washed from the continent, and by waste gas that migrates upward from the methanogenic bacteria that inhabit all crustal material, especially the sedimentary apron that fringes the continental land masses. These vast submarine gas reserves are believed to contain at least 3,000 times the volume of methane that is presently in the atmosphere.

Seismic activity or significant temperature changes can rupture these methane hydrates, and on occasions, unpin the overlying sediments, allowing them to slip down the slopes that fringe most continents. Some submarine landslides have been very large indeed, and methane that is released in this abrupt fashion represents a major threat to the global climate. One relatively recent landslippage appears to have involved an area of seabed that was almost the size of Scotland, according to British marine scientists.

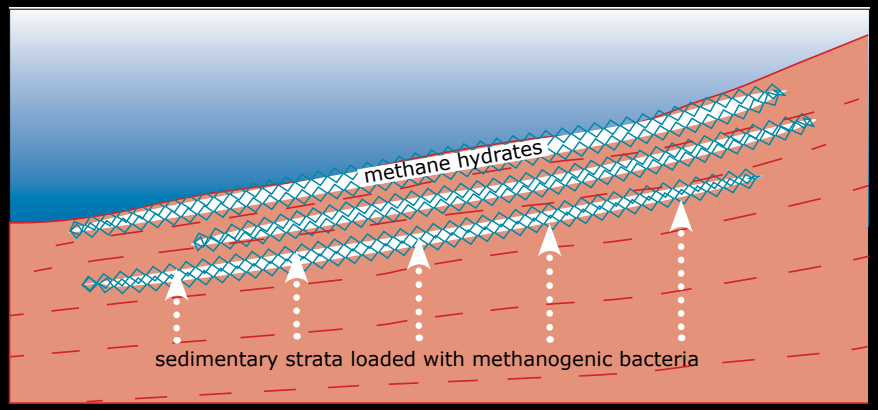
Such explosive releases of methane are now believed to have been responsible for several of the more abrupt temperature rises that ended glacial episodes in the past, and appears to have contributed to the end of the world's longest and most savage ice age some 630 million years ago.[6] Methane also helped to wipe out more than 90% of marine species and 70% of land life during the world's worst mass extinction 251 million years ago.*

From our perspective, the widespread disintegration of polar permafrost and marine hydrates thereby represents an ominous evolutionary development ...

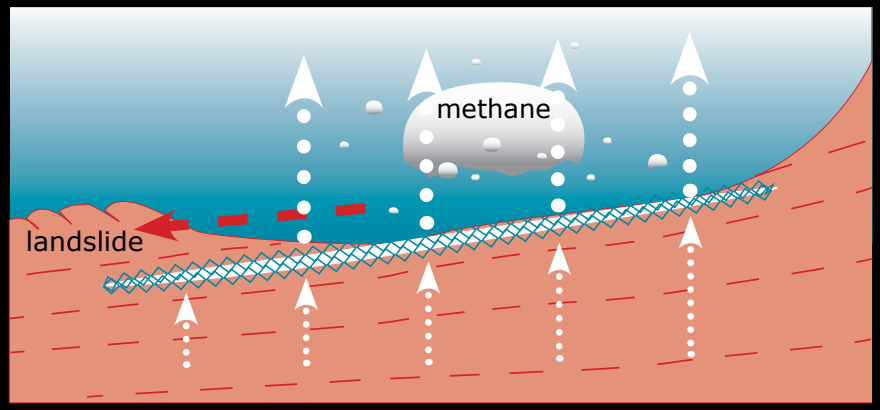
Methane Hydrate
(schematic)



Cold seas



Warm seas



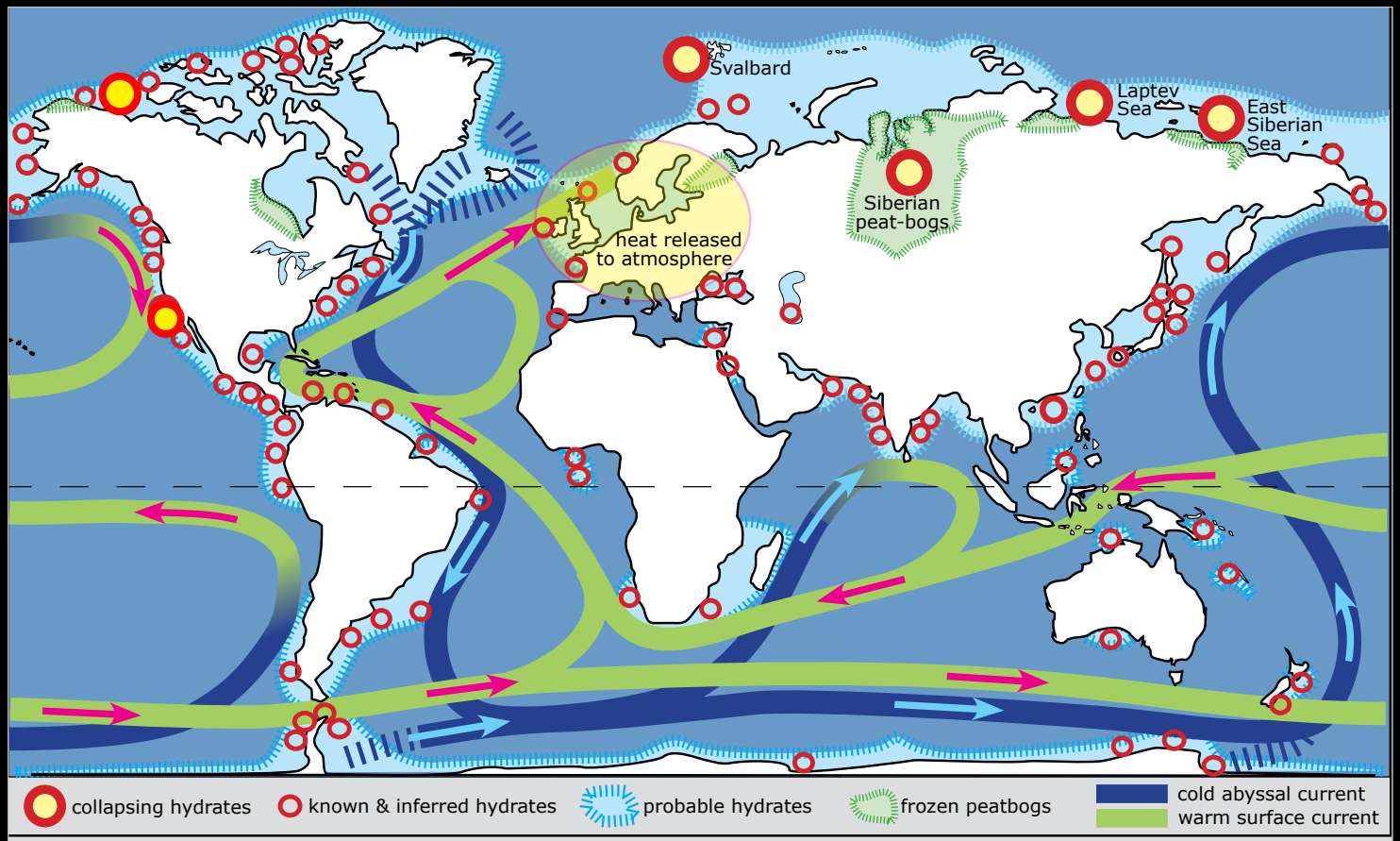
* Douglas H. Erwin 2006, "Extinction" (Princeton University Press) pp.174–179

Global Hydrates

Russian scientists have measured aerial concentrations of methane that are up to a hundred times the background level, spread over many thousands of square kilometres of the Siberian continental shelf. They also saw patches of sea that were foaming with the gas as it bubbled up from the sea floor in the form of "methane chimneys".

They believe that vast blankets of submarine permafrost, which used to act like a lid to prevent the gas from escaping, have recently melted, releasing methane from underground deposits that predated the last glacial period.

Scientists on a British research ship said that they too had recorded methane plumes bubbling from a relatively shallow seabed (~400m deep) in an area covering about 50 square kilometres off the west coast of Svalbard. They counted about 250 plumes at that site alone and then discovered a second set of plumes rising from about 1,200 metres.



The flow pattern of ocean currents, schematically traced out above in blue and green, represents the thermo-haline circulatory system that girdles the planet and helps to redistribute heat throughout its oceans. The system is largely driven by the sinking of cold dense salt water in polar regions while the westward flow of the equatorial current is generally helped on its way by trade winds.

It takes somewhere between 1000 and 2000 years for water to complete the cycle and this continual redistribution of heat energy plays a major role in maintaining the world's weather patterns and global temperature.

Whenever the polar drive slows, the seas' well-defined temperature layers mix, and the ocean warms. This dissolves some hydrate ices, releasing their methane. Similarly, when the oceans warm the atmosphere, the tundra permafrost degrades, releasing some of its methane.

A vast expanse of frozen swampland in western Siberia has now begun to release methane that has been locked in its permafrost for some 27,000 years. So much gas is now escaping that some lakes are refusing to freeze, even in midwinter.

Hydrate collapse

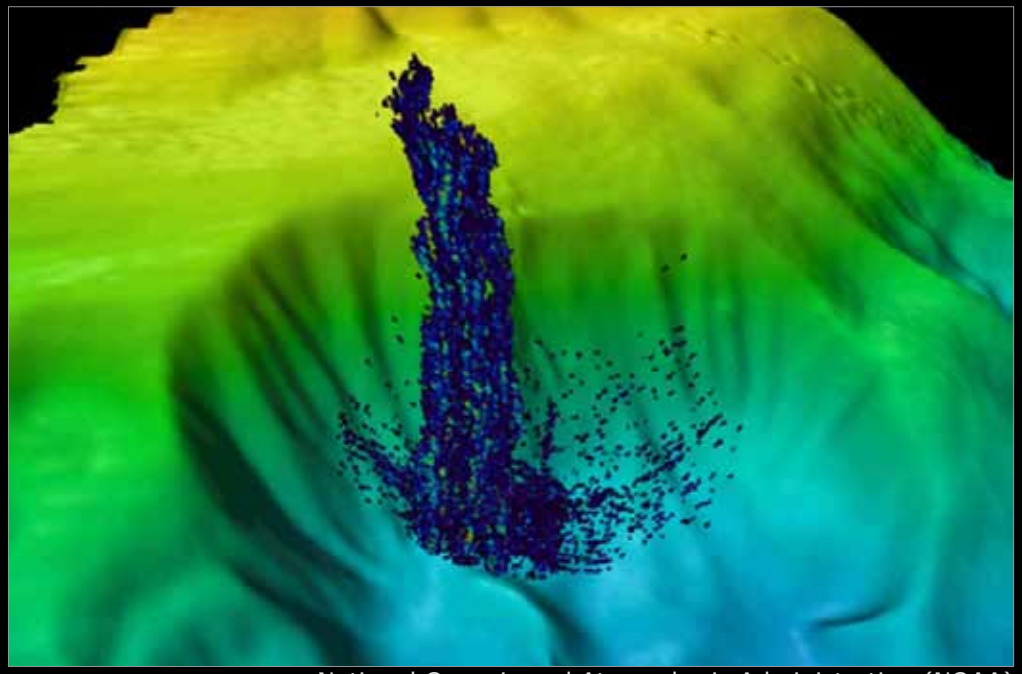
This is a sonar image of a plume of methane bubbles rising from disintegrating hydrates on the seabed off the coast of California. It was discovered by accident during a test of newly developed multi-beam sonar equipment by the National Oceanic and Atmospheric Administration (NOAA). The slumping pattern around the plume suggests a recent landslide.

This methane plume originates at a depth of 1,800 metres and after rising about 1,400 metres from the seabed the column of bubbles gradually disappears as the methane dissolves into the seawater, converts to CO_2, and helps to acidify the seas.

This absorption shows up most clearly in the sonar image of the Californian plume which peters out entirely after rising 1.4km through the water column.

Methane injected into the world's oceans in this fashion not only increases their acidity, it extracts free oxygen from the water and reduces the ocean's future capacity to absorb CO_2 from the atmosphere, thereby maximising the greenhouse impact of our own carbon emissions. When the water's free oxygen is exhausted, the sea's biota gradually dies. Such oxygen starved 'dead zones' are multiplying and expanding around the world.

Data collected between 1981 and 2004 by researchers from the University of East Anglia, UK,[1] suggest that the vast Southern Ocean, one of the world's largest carbon sinks, has been saturated with CO_2 for at least two decades, and its high level of acidity is already showing up in the biota.



National Oceanic and Atmospheric Administration (NOAA)

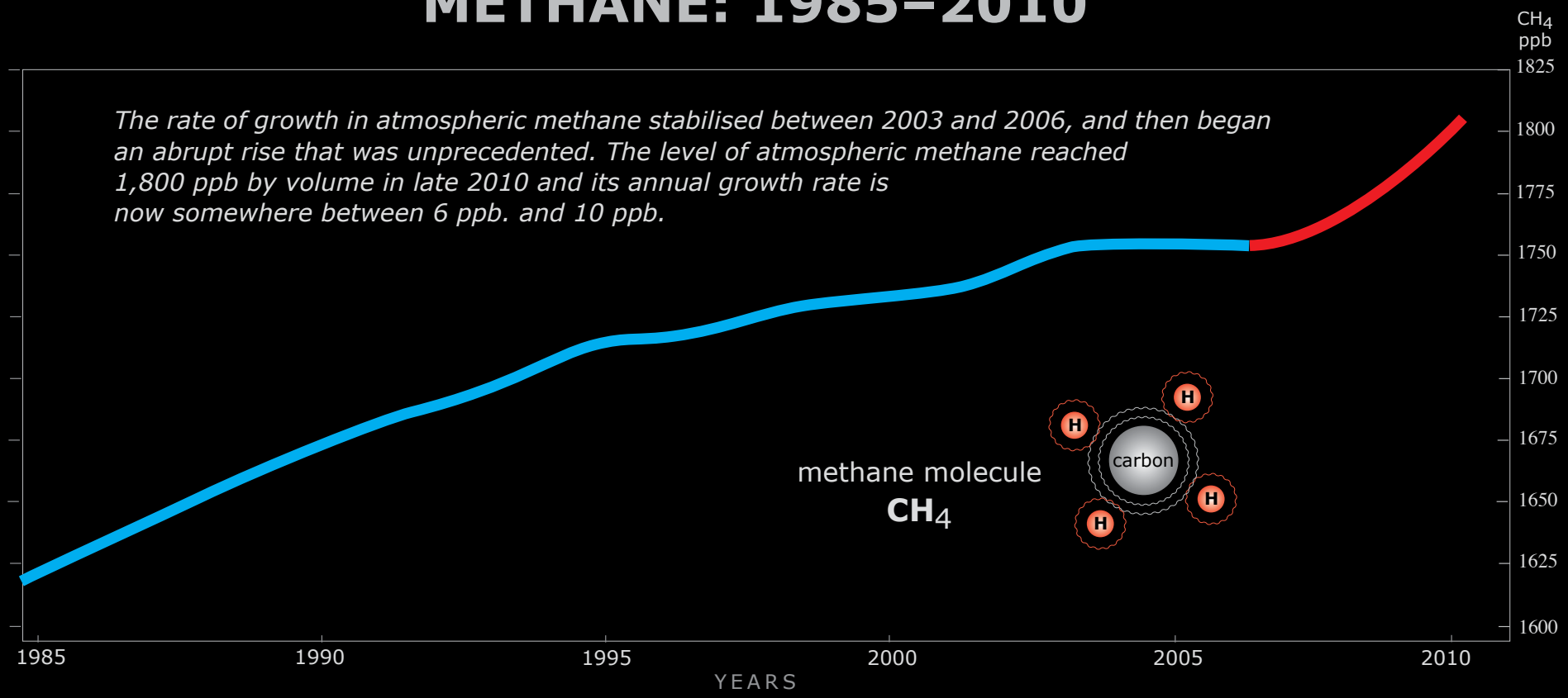
The carbonate casings that protect one species of plankton (*Globigerina bulloides*) have proven to be 30%–35% thinner than shelly casings deposited by the same plankton about 250 years ago, just before the modern industrial era began. According to recent drill-core evidence gathered from the Great Barrier Reef, these casings are now far thinner than they have been for at least 200,000 years.[2]

Planktonic organisms underpin the entire marine food chain, so any threat to its food base is an ominous sign indeed. Even more ominous is the fact that marine acidification occurs as the water accumulates hydrogen ions. Once again, hydrogen is life's final regulator.

1. Lough, J., Australian Institute of Marine Science. ABC News in Science: http://www.abc.net.au/science/articles/2005/09/30/1470355.htm

2. Kleypas, S.R. Palumbi, O. Hoegh-Guldberg, R. Van Woesik, J.C. Ogden, R.B. Aronson, B.D. Causey and F. Staub."A call to action on coral reefs." *Science*, 10 October 2008: 189b-190b (DOI: 10.1126/science.322.5899.189b)

METHANE: 1985–2010



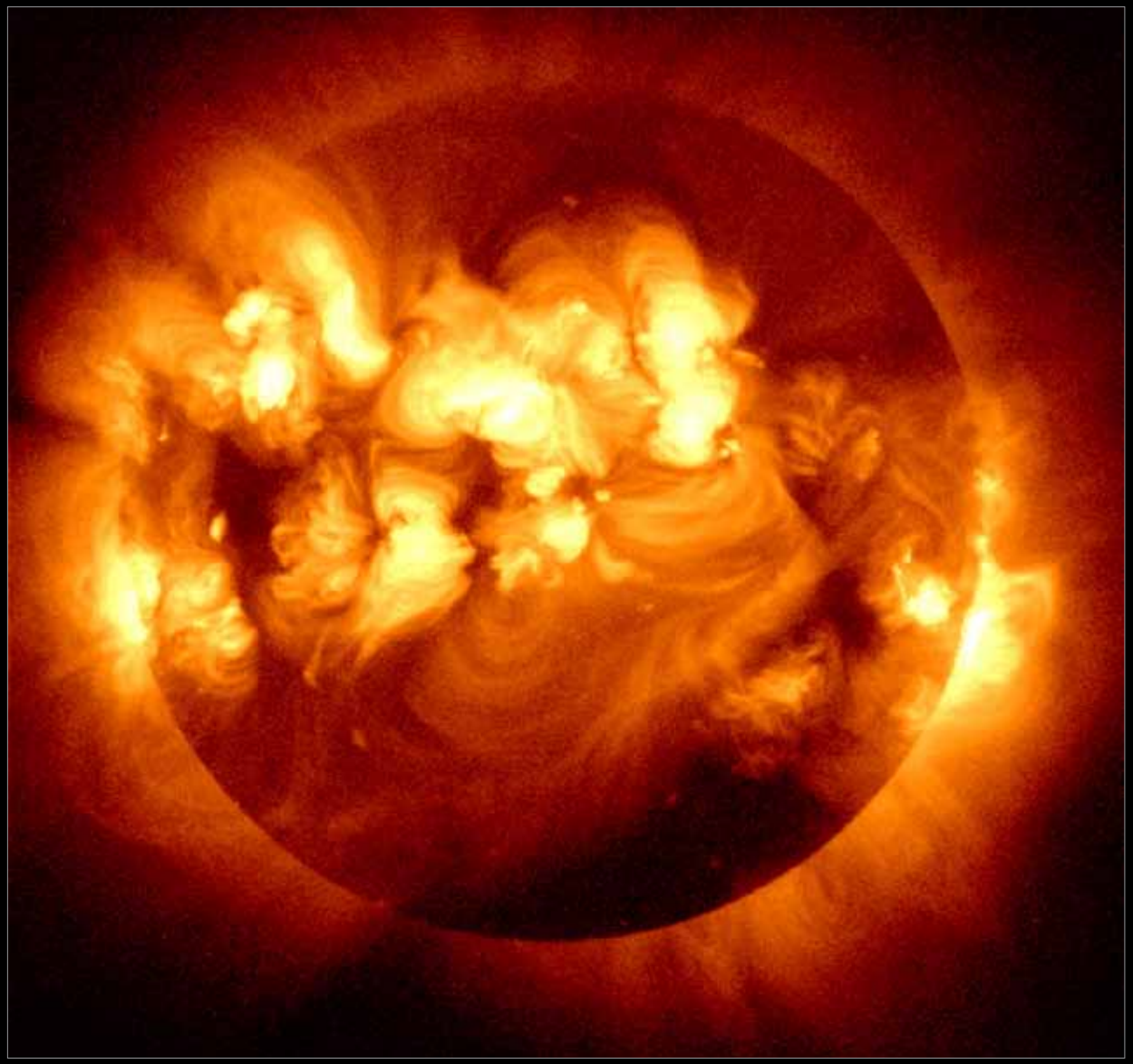
A reassessment of methane's Greenhouse impact

The volume of methane in the atmosphere has grown fairly steadily since the beginning of the modern industrial era (~1750) when it was only about 680 ppb. When the daily rate of methane decay finally caught up with the increased rate of injection in 2003, the level stabilised for almost four years. Towards the end of 2006 however, the methane level began to surge again, due no doubt to the accelerating disintegration of submarine and tundra hydrates as the polar ice began to melt.

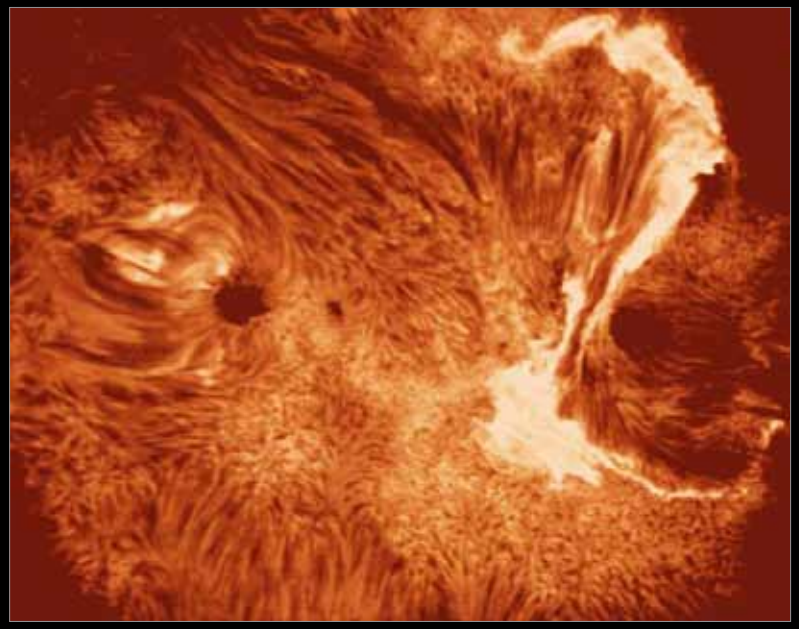
It has been recently calculated that methane's interaction with other constituents of the atmosphere, especially hydroxyl (OH) and sulfate particles, has enhanced methane's warming effect by 20–40% over previous estimates. Climatologists at NASA's Goddard Institute for Space Studies now believe that methane may account for up to a third of the global warming from greenhouse gases between 1750 and today.[7]

HYDROGEN: LIFE'S PRIMARY DRIVER

The primary drive for the Earth's biosphere comes from the fusion of hydrogen atoms in the Sun's interior. The energy radiated to earth fluctuates in direct proportion to the number of storms that perturb the Sun's surface. The more solar storms there are, the warmer our planet becomes.



Storms on the Sun, Dec. 2006 (magnetic imaging, Hinode International spacecraft, JAXA/NASA)

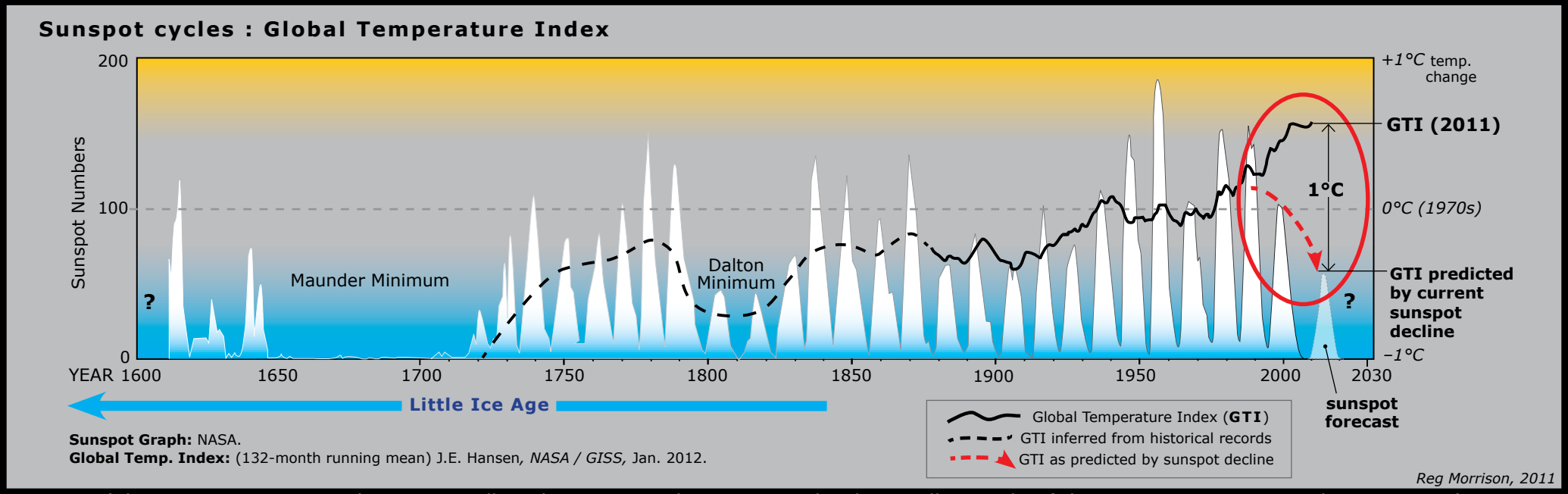


LEFT & ABOVE: The dark spots that appear on the surface of the Sun are all that we see of the violent storms that usually rage across its face. These composite images show the vast eruptions of energy that accompany those storms. Such eruptions, known as faculae, are a primary cause of the 11-year cycle that modulates Earth's temperature fluctuations.

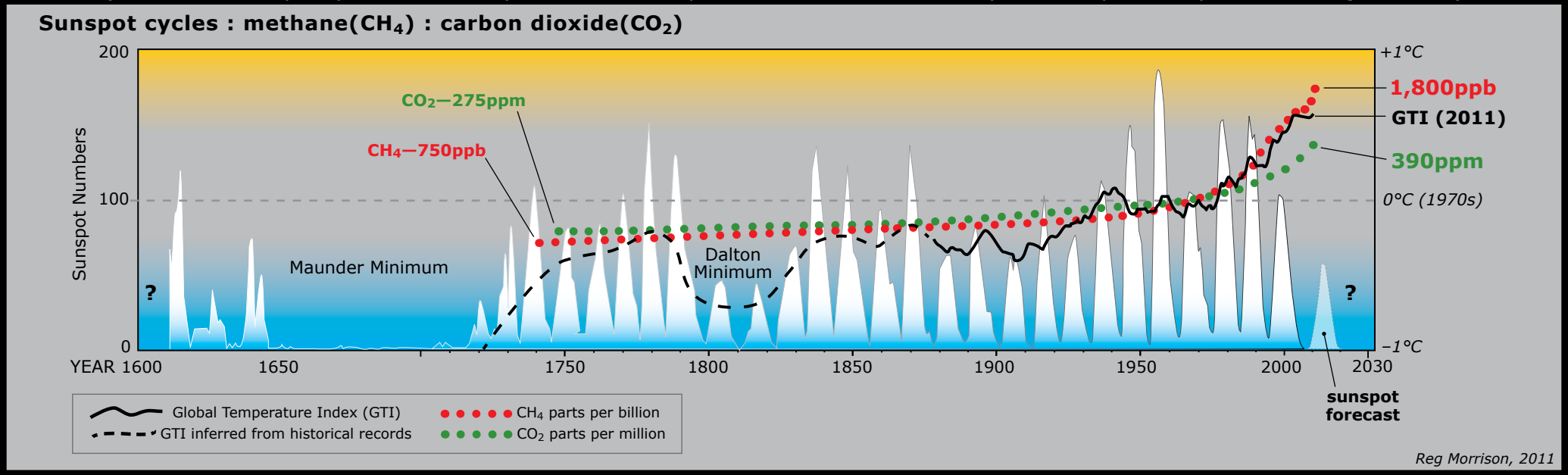
The Sun's face is currently blemish free—a relatively rare phenomenon. So Earth's global temperature should be plunging.

But it isn't ...

The Global Temperature Index has diverged from the sunspot trend for the first time in 400 years.



(The current sunspot cycle, No.24, will peak in 2013 and promises to be the smallest cycle of the past 100 years according to NASA)



The coincidental leap in atmospheric methane and carbon dioxide offers an explanation for the discord.

EARTH'S ENERGY GRADIENT

The most definitive measure of chaotic disturbance within the energy gradient that envelops our planet is the mass extinction of species.

A secondary indicator is a change in the composition of the atmosphere. And inevitably, they are linked. Any change in the volume and diversity of the modern biota will be unerringly reflected in the atmosphere by changes in its molecular composition and temperature.

The current collapse in biodiversity is without precedent in the recent fossil record. It is often likened to the massive biological collapse that occurred 65 million years ago when the Earth was hit by a cosmic missile, either a comet or an asteroid. This time, however, the cause of the biological trauma is *not* external.

Armed with a large brain, abundant hydrocarbon fuel and sophisticated technology, *Homo sapiens* has impacted the biosphere with all the force of a cosmic missile. The massive redistribution of energy engendered by this assault has left its scars throughout the biosphere.

More than half of the planet's rainforests have been removed, thereby eradicating vast numbers of endemic species; its seas have been emptied of large fish, and its atmosphere altered by the addition of heat-retentive gases, notably carbon dioxide and methane.

This massive environmental impact has been largely due to our ability to extract vast quantities of the solar energy that is fossilised in coal, oil and natural gas, and redistribute that energy in the environment.

Our culture's dependence on these hydrocarbon fuels has incurred a second penalty, and this too, will be explosive. Energy starvation will ignite our most ancient and most lethal timebomb—mysticism ...

Desertification via overstocking with inappropriate species (cattle) near Finke, NT.

Former rainforest (harvested to make woodchips), Scottsdale, TAS.

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 most mystical tribal groups 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. The corrosive mental derangements born of religious and political mystical beliefs will easily derail our global efforts to cooperate against the looming threats of starvation, disease, and climate change—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. They will ensure that the tribal distrust and hatred that lingers between nations, religions, races, and political groups swells to a crescendo—just as the environment begins its counter-offensive against the current plague of *Homo sapiens*, the primary destabiliser of this planet's energy gradient. ...

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

Victims of the Nazi Holocaust

*See also: 'Evolution's Gamblers'

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 our case the difference is that it is entirely intangible and very well concealed, residing as it does in the three billion base pairs of our DNA.

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 our DNA's primal imperatives, 'survive and reproduce', unequivocally identify it as a genetic artefact.

Whether our mysticism relies on a belief in supernatural forces such as gods, angels, witchcraft, and intergalactic aliens, or whether we believe in luck, tea leaves, memes, astrology or market forces, the exact 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 our mysticism into an an evolutionary timebomb of unparalleled power. It may even destroy us.*

The 'Rational' Delusion

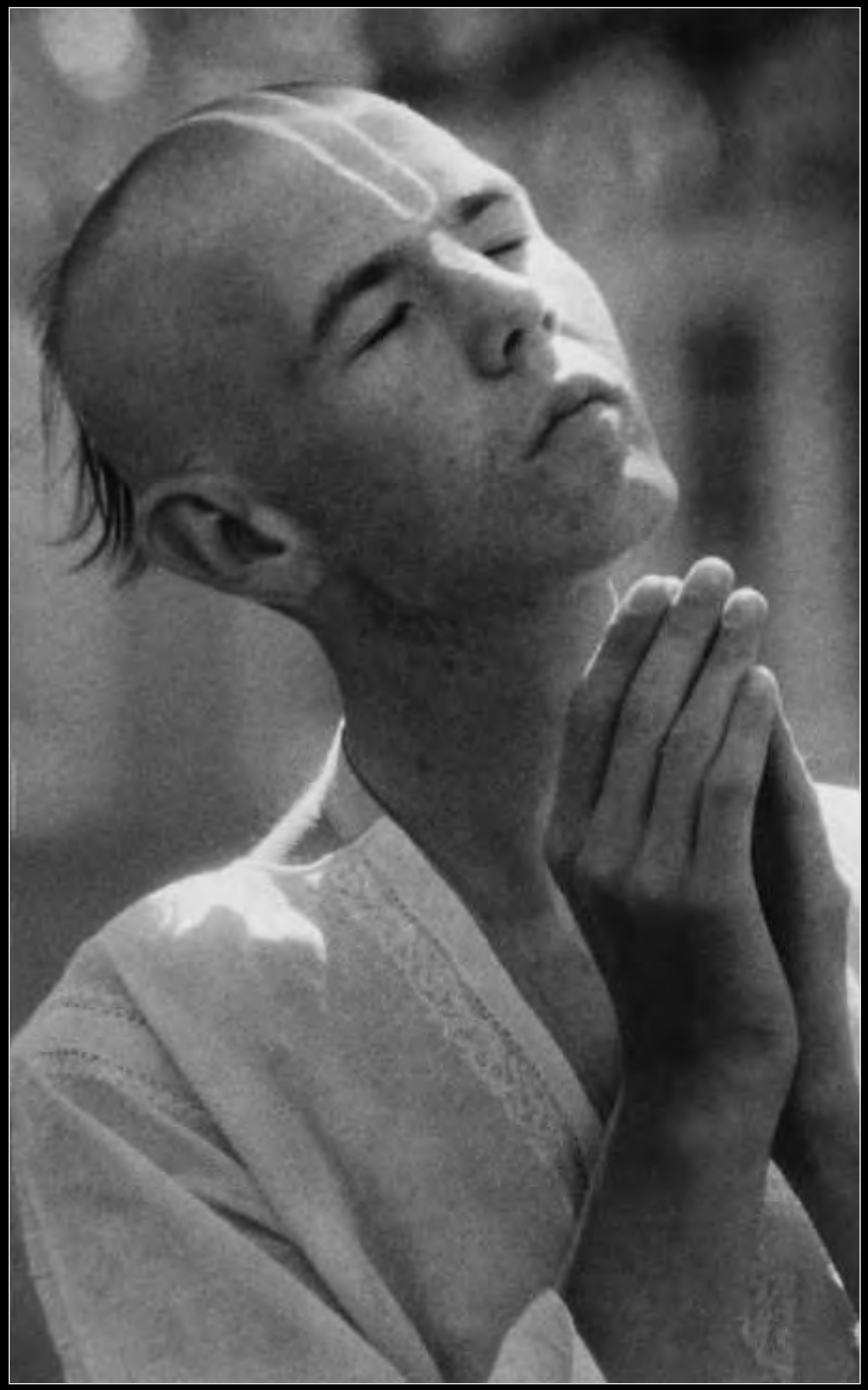
Reproduction is the pivotal feature of all biological existence, and the complex machinery that drives our sexual urges and regulates our daily behaviour is embedded throughout our DNA. It ensures that this crucial machinery lies beyond the reach of our new and incompetent rational cortex.

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 ...

*See: 'Evolution's Gamblers'



Overriding the Rational Cortex

In order to secure this crucial streak of insanity in an increasingly rational brain it was first necessary for humans to perceive (quite accurately) that their genetic imperatives—in the form of instincts, feelings and desires—represented a source of considerable wisdom and strength; and second, to believe (quite irrationally) that this inner wisdom had its roots in an invisible world of super-intelligence, a mystical world that lay beyond rational comprehension.

It was the sweetest of solutions. Such perceptions were guaranteed to produce a faith-dependent species that believed itself to be thoroughly separate from the rest of the animal kingdom, but followed its genetic instructions to the letter—and left more offspring as a consequence.

Here was a gene-driven animal just like any other, and yet one that believed itself to be under special guidance that was not merely 'spiritual', but in most instances 'divine'. Here was a very practical insanity indeed, one that eventually enabled this physically under-endowed species to devour the planet like a ripe fruit. (*Homo sapiens* now appropriates almost 40% of the solar energy that is photosynthetically trapped by the world's terrestrial vegetation.)

Via the culturally sanctioned device of mysticism, in a multitude of forms, here at last was a substitute for the fur, claws and fighting teeth that evolution had failed to provide. And here, concealed within the dazzling scabbard of mystical language, was the Excalibur that would rescue our species from the brink of extinction and launch it to global domination and evolutionary stardom.

Since mysticism cuts in most powerfully whenever our genes come under physical threat, its clear purpose is to circumvent our talent for critical analysis and reasoned thought in desperate times. It is even possible that human mysticism evolved specifically to counter the dangerous expansion of the rational cortex in this physically inadequate animal. *

*See also: 'Free Will? ... It's Unavoidable!'

The mechanics of delusion

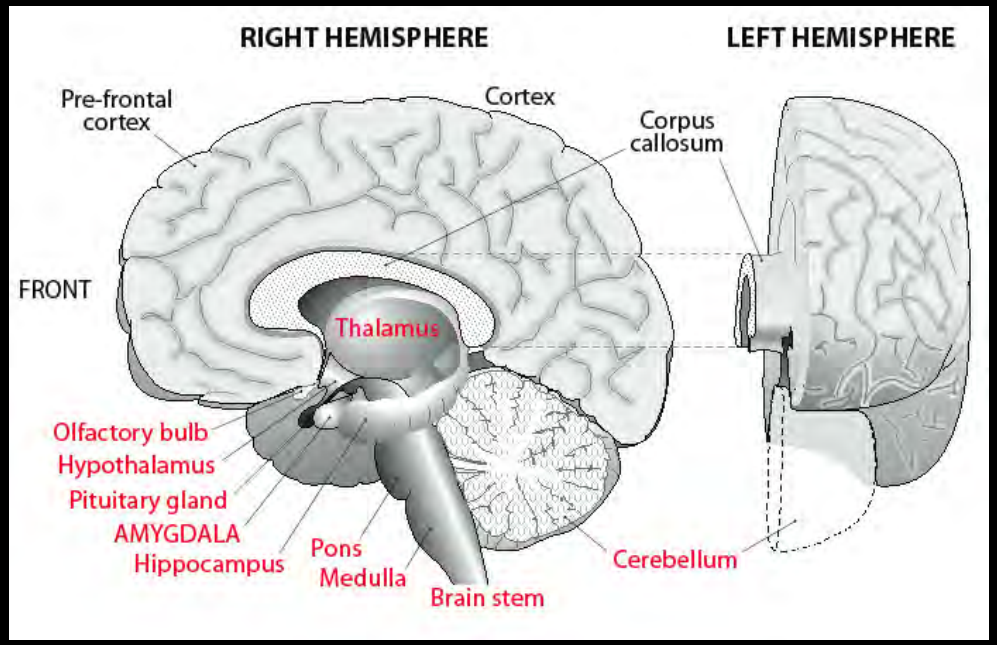
The brain structures and neuronal pathways that achieve these crucial genetic responses have now been largely identified. They lie, as might be expected, in the older structures at the core of the brain. Central to these are the hypothalamus, the pituitary gland and the small, almond-shaped amygdala.

The amygdala seems to be primarily involved in appraising the genetic significance of situations in which an immediate threat might be involved. In other words it governs the fight-or-flight reflex, and determines the particular thresholds of aggression and discretion that characterise each one of us.

Meanwhile the hypothalamus, in conjunction with the pituitary gland that sits just below it, seems to act as the master control system for a wide diversity of other phenomena, including structural growth and the physical expression of mental states. Its speciality however, lies in the expression of emotions. Electrical stimulation of one part of the hypothalamus can unleash rage and a full-blown attack response, both in humans and other mammals, but stimulation of a neighboring part of the hypothalamus can elicit feelings of intense pleasure.

Since the hypothalamus and amygdala are part of the 'limbic system', which includes all of the ancient mammalian-reptilian structures at the core of the brain plus the brain stem, they are ultimately linked both to the sensory system and to the autonomic nervous system.

The limbic system thereby provides our genes with an automatic 'choke' that is able to flood the entire body with the appropriate chemistry for slipping into top gear from a standing start, bypassing the rational brain entirely.*



Limbic systems hard at work 'by-passing the rational brain entirely.' Perth, WA.

*Appendix 6 ('Practically Deranged')

‘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 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 factitious characters and events that are portrayed on stages and screens around the world.

This ancient neuronal short-circuit switches in 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, ‘market forces’, 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.

'EMOTION' IS GENES AT WORK

'Whenever instinctive beliefs and emotional feelings arise we may be sure that genetic imperatives have assumed control and our rational cortex has been bypassed.

There is no reason to suppose it was any different 10,000 years ago, or even a million years ago. In fact, the deeper we probe into the past the clearer it becomes that the massive complex of customs, rituals, faiths, and social mores which help to regulate our lives under the banner of culture, are simply relics of previously successful genetic behavior—behavior that contributed so significantly to human survival that it became embedded in the society's cultural foundations.

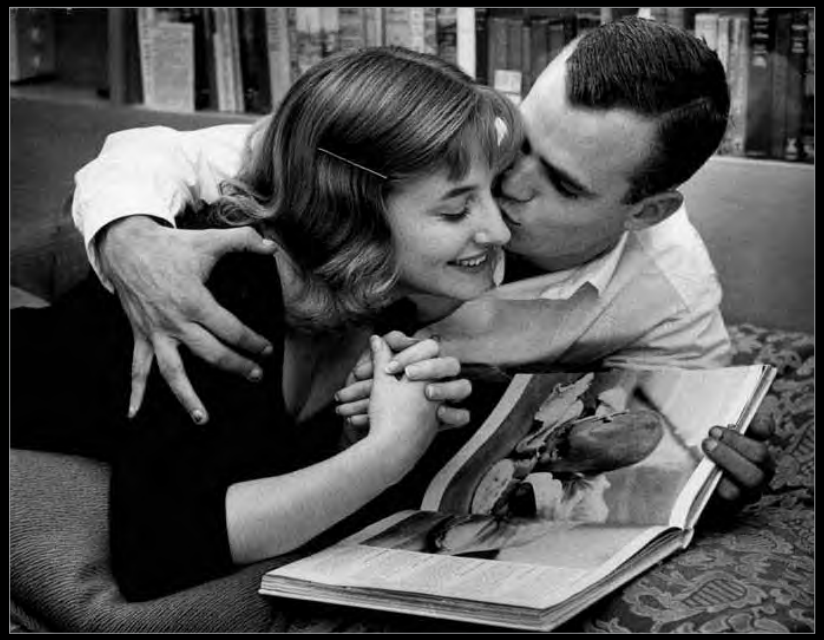
In other words the iconography, symbolism, art, ritual, and other embellishments of a culture might alter continually and dramatically with the passage of time, but the underlying theme and central purpose remains invariable: to reinforce our pair bonds and tribal bonds, to coordinate the tribal group, and to inspire altruism and in some instances, heroic aggression, to secure the survival of the genetic line.

So 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, but the triumph of the gene over gene-threatening rational thought.'

(***The Spirit in the Gene*** p.240)

ABOVE: When the usual checks and balances of the frontal cortex have been inhibited to some degree, such as in those suffering from the spectrum of brain dysfunctions known collectively as autism, the amydala and the hypothalamus enjoy greater freedom, leaving the sufferer prone to outbursts of incoherent rage and frustration.

ALL BEHAVIOUR IS GENETIC



This is the molecular reality that binds all life together.

A genetic tool-maker

Very few people are aware that we share our planet with an ancient tool-making animal whose existence entirely depends on a hand weapon of such sophistication that modern humans failed to match its complexity or efficiency for most of our species' 200,000-year existence. Yet this un-recognised toolmaker, the Retiarius or Net-casting spider, only has about 1,000 neurons in its tiny brain.

As twilight falls in my unkempt garden, each of these spiders builds a minimal silk scaffold directly over a pre-selected ambush site. The spider then switches on two additional sets of specialised silk-glands, and using the three very different products that come from these glands it spends the next half hour meticulously knitting its hunting net. This mobile kill-ing tool is by far the most complex and efficient hand-weapon the animal world has ever produced.*

The crucial moment comes when the spider bites though a main suspen-sion line that holds the hunting-net under tension in its vertical 'knitting' position. This allows the net to drop into loose horizontal folds that are suspended only by the flanking support lines.

This crucial deconstructive act not only makes the hunting-net semi-mobile, it also implies a level of architectural judgement and engineering competence that humans have always assumed to be theirs alone.

Since the spider's offspring disperse soon after they hatch from their eggs, they never see their mother toiling at her nightly knitting. It is therefore clear that the net-manufacturing skill subsequently displayed by her progeny is not learned, but is genetically inherited. ...

(Male Net-casters manufacture nets and hunt like females in the early part of their short lives, but this ceases as soon as they are old enough to mate.)

A female Retiarius (*Deinopis subrufa)* knitting her hunting net. Sydney NSW.

*See Appendix 7 ('Net-casting spider')

A female Retiarius pleats her fibrous silk by crimping it with her feet. Sydney NSW.

GENETIC CRAFTSMANSHIP* It is worth noting that none of the silk made by this ancient spider is sticky in the way that modern orb-webs are, but the fibres that form the bulk of the hunting net are so fine they will even snag on the imperfection in plate glass. The spider adds enormous elasticity to these fibres by pushing them into tiny pleats with her hind legs (LEFT).

Having manufactured her hand weapon and dropped it into its mobile attack position, the spider then performs a five-point weapon-check. She stretches the rectangular hunting net four times—once from each corner—and then carefully extends one leg to the chosen target area to ensure that her own height is perfectly attuned to the site.

When her long and painstaking preparation is complete she settles down to wait for suitable prey to enter her ambush zone.

The moment anything moves in the area it triggers her attack reflex. Holding each corner of the rectangular hunting net with the claw-tips of her four front-legs the spider spreads her legs in a fast downward lunge, dabbing the net on to her prey as it passes beneath her. She then retracts her legs, lifting her prey off the ground, and waits for it to exhaust itself by struggling before she begins to feed. (See Appendix 7)

This entire sequence of behaviour appears to demand a level of rational forethought and engineering comprehension that only a massive brain with vast neuronal resources could possibly achieve. Yet by virtue of a meticulous sequence of constructive and deconstructive behaviour, this hunter's tiny brain appears to fully comprehend the mechanics of its complex 'hand' weapon. What is more, it acquires this talent via genetic material alone. This validates the proposition that much of our behaviour too, may represent a cryptic accumulation of genetic 'memory'.

* For a more detailed account, read 'Meet the Toolmaker'

'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.

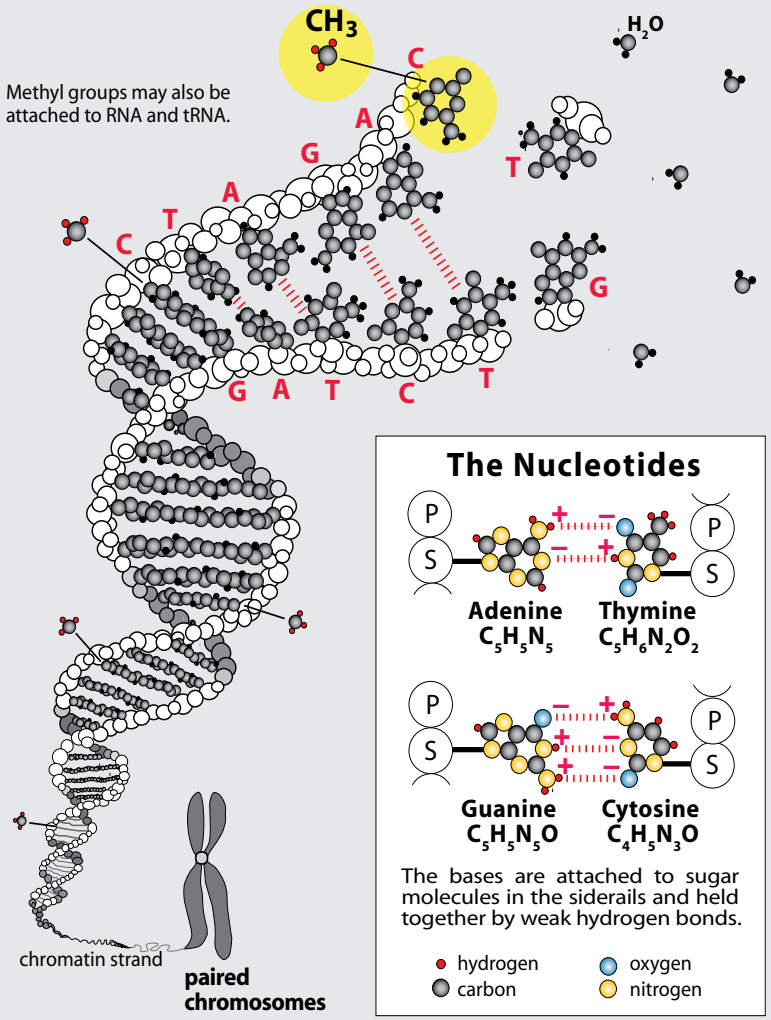
Consequently, methylation plays a major role in manipulating our perceptions of the world around us and plays a crucial role in shaping our day-to-day behaviour. All behaviour is genetic in origin. No other driver exists.

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



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'*

THE 'SOAP-FILM' OF LIFE

Earth's web of life is like a biological soap film on the planet.
It betrays any changes in chaotically fractal fashion.

During the past 10,000 years our species has consumed vast quantities of crustal material including, in recent time, almost 40% of the daily by-product of Earthly photosynthesis. Via this massive energy consumption and by 'breathing out' our voluminous wastes, especially carbon dioxide and methane, we have disturbed those fractal patterns of energy dissipation that previously characterised our planet's Chaotic biosphere.

Chaotic energy systems invariably respond in wholly unpredictable fashion to the smallest alteration in their energy flow. By clearing vast areas of forest to plant crops and graze stock, and by transferring large quantities of fossil hydrocarbons from the crust to the atmosphere, humans have massively altered the pattern of energy flow throughout the biosphere.

It has been calculated that the present global population of about 7 billion humans, armed with modern technology, annually achieves about 2,400,000 times the environmental impact that 4–6 million hunter-gatherers would have inflicted 12,000 years ago.[8]

The trouble with chaotic systems is that once they have been disturbed it is not possible to return them to their original flow pattern—or to any approximation of that pattern. After an extended period of chaotic rearrangement, the flow pattern will automatically settle into a wholly new regime of energy dissipation. However, this new flow pattern may take up to 100,000 years to stablise.

As the primary destabiliser of the planet's energy gradient and the most voracious consumer of energy on this cosmic Camelot, humans now face imminent energy 'starvation' and rising levels of mystically fuelled discord and aggression. Sadly, this exquisitely talented species now seems to be on evolution's 'primary target' list.

soap film: stable air

soap film: disturbed air

By 'Breathing Out' on the Biosphere:

- ***We have dramatically increased the rate of extinction throughout the biota.***
- ***We have altered the composition of the atmosphere, directly and indirectly.***

Since these factors regulate the energy flow throughout the biosphere they are the physical managers of our cosmic habitat.

Having deformed the pattern of energy flow between the body of the planet and the matrix of space, we must now prepare to ride out the evolutionary backlash as best we can.

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 darkest 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).

APPENDIX

Following pages:

EPIGENETICS

A genome's pattern of methylation ensures that each cell expresses only those proteins that are appropriate at the time of transcription. Altered methylation changes gene expression by changing the way DNA is folded. Genes in tightly compressed DNA are not readily expressed, while DNA that is more loosely packed is more accessible to the machinery involved in transcribing it into messenger RNA (mRNA), and thereby, into protein. Appropriate DNA methylation is therefore essential for the proper development and functioning of an organism.

Bees perfectly illustrate this. The only genetic difference between the large fecund queen bee and her army of small, sterile, female workers is the pattern of methyl tags on their otherwise identical DNA, and this difference is solely determined by the kind of food that is fed to them when they are larvae. Those selected as future queens are fed a specialised diet of 'royal jelly'; worker-larvae get little of this.

Viruses, bacteria and chemical pollutants are similarly able to disturb a genome's basic sequence of methyl tags. Even the body's hormonal response to stress, and the processes of aging can alter the methylation pattern of DNA and directly interfere with the structure and behaviour of an organism—often in heritable fashion.

Our species offers no exception to these rules. So although our genes determine our fundamental structure and behaviour, our overriding epigenetic code orchestrates all the finer details of our mental and pysical existence. Altered patterns of methylation can also compromise human immune systems, producing a range of ailments such as diabetes, some cancers, arthritis, asthma, and allergies that degrade the fitness of the population as a whole. Traumatic stress in childhood, or a lack of appropriate parental nurturing during our developmental years has also been shown to slightly alter our methylation patterns. Meanwhile, methylation is the essential factor that shapes our memory (short-term and long-term), and this too, can modify our judgement and behaviour. ❇

ABOVE: A honeybee worker forages for nectar and pollen in a bottlebrush flower. With its larval diet restricted to 'bee bread' and little or no royal jelly, its methylation pattern consigns it to a short, sterile life of hard labour. A queen, by contrast, is large, highly fertile, and spends her long, sedentary life extruding thousands of eggs.

ENDOSYMBIOSIS: *An intimate partnership between two unrelated organisms in which one lives inside the other and both benefit, chemically or physically, from the union. Such partnerships are often described as mutualistic.*

A French-German botanist, Andreas Schimper, made the revolutionary observation in 1883 that chlorophyll-loaded bodies in green leaves looked like cyanobacteria and reproduced themselves independently.

His work was taken up in the early 1900s by the Russian biologist, Konstantin Merezhkovsky, who did not believe that natural selection could explain the full range of evolutionary diversity. Based on Schimper's observations and on his own work with lichens, Merezhkovsky proposed in 1909 that the acquisition and inheritance of 'microbes' was central to the process of evolutionary diversification. He called the phenomenon symbiogenesis.

American evolutionary biologist Lynn Margulis resurrected this concept in a 1966 paper and later expanded it into her Serial Endosymbiosis Theory (SET). This has become widely accepted as an explanation for the spectrum of variants that is offered to the environment for final selection.

The theory has been corroborated by the discovery of bacterial DNA within the cell's cytoplasm but outside the nucleus. It seems to be associated with many of the cell's organelles and autonomously manages their growth, repair and replication without instruction from the nucleus.

The Serial Endosymbiosis Theory not only proposes that eukaryote cells evolved and diversified by this process, it suggests that speciation throughout the biota is often the result of alien organisms or segments of alien genetic material becoming incorporated in the host's genome. ❇

NB: For the sake of good commmunication the word 'bacteria' has been used in its traditional collective sense throughout this essay. It therefore refers to minimal, membrane-bound organisms that lack a nucleus and other internal structures (organelles). It includes both of life's primordial branches, the archaebacteria and the eubacteria.

'FAUSTIAN BARGAIN':

In this particular context the reference to the 'Faust' legend provides a literary analogy* for the ultimate energy debt that occurs due to an increase in an organism's energy uptake.

• As an interchangeable extension of the Earth's crust life itself is part of the planet's entropic 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.

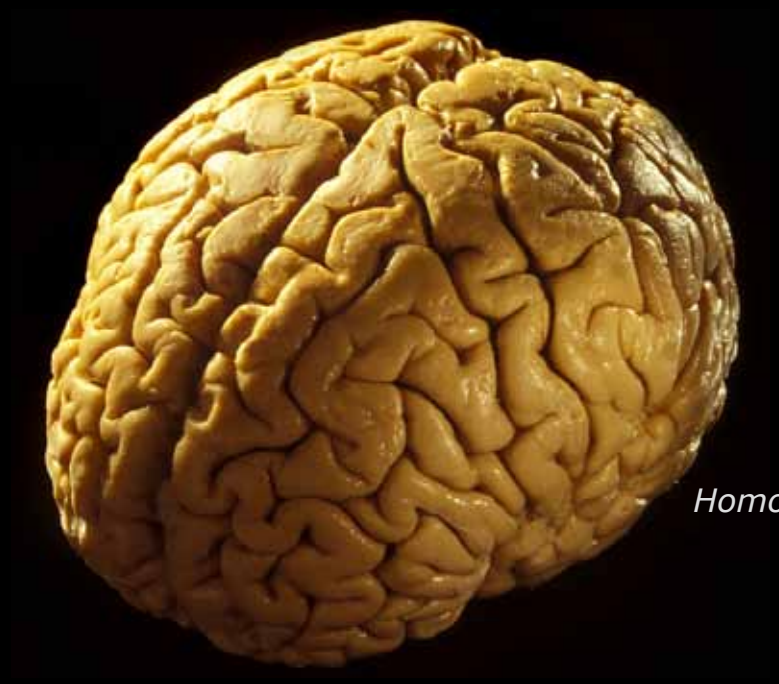
• Evolution is the process by which organisms acquire complexity in order to gain access to energy sources that lie beyond the reach of their simpler competitors. Any innovative increase in their rate of energy extraction always entails an evolutionary disadvantage of even greater significance, in most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

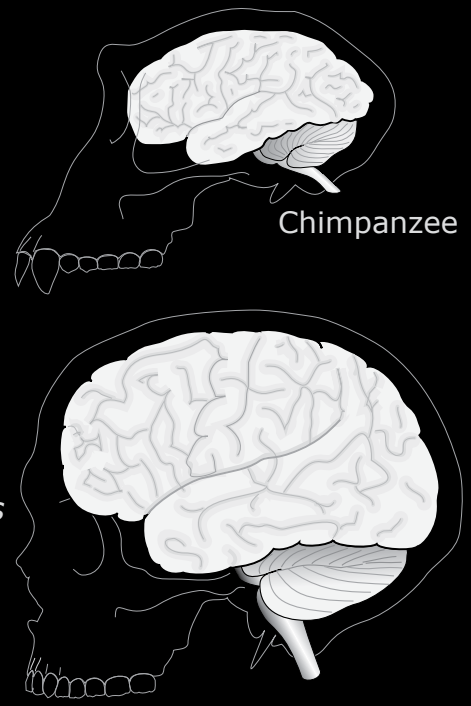
• In human society the same Faustian factor emerges in the form of **Jevon's Paradox** in which any energy savings gained by improved technology invariably leads to greater consumption due to increased uptake of that technology. The steam engine and the combustion engine are eloquent illustrations of 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 adjective '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.*

OUR FAUSTIAN BRAINS: high-yield/high-cost

However ill equipped and incompetent we may be in an evolutionary sense, we humans are remarkable in one physical respect: our brain-to-bodymass ratio—in academic terms, our encephalisation quotient (EQ). This ratio is roughly one third larger in humans than it is in our nearest rivals, the elephants and dolphins. By comparison, our evolutionary cousin, the chimpanzee, has an EQ that is only one third the size of ours.





SPECIES	EQ
Human	**7.44**
Bottlenose dolphin	5.31
Elephant	5.25
Orca	2.57
Chimpanzee	**2.48**
Rhesus monkey	2.09
Whale	1.76
Dog	1.17
Cat	1.00
Horse	0.86
Sheep	0.81
Mouse	0.50

Even this evolutionary asset conceals a **Faustian penalty**.

The human brain constitutes only 2% of the body's weight, but it can consume 20% of the body's energy.

Brain cells harvest their energy from the standard energy carrier for all metabolism, adenosine triphosphate (ATP). They do this by detatching a phosphate unit from its phosphatic 'tail'. But the brain's reserves of ATP must then be continually replenished by the multitude of mitochondria that are built into the brain's nerve cells. And it requires an input of two hydrogen protons to build each molecule of ADP into its three-phosphate form, ATP.* ❇

* see ATP on page 13

THE GENERAL ADAPTATION SYNDROME (GAS) [3]

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. . . .

The GAS 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 (see GAS page 37).

It now seems likely that some of this behaviour modification may be produced epigenetically via changes in the methylation pattern of DNA (see DNA page 9).

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. . . .

GAS — 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. . . .

GAS — 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. ❇

'PEAK OIL'

In 1956 an American oil geologist and geochemist, Marion King Hubbert, predicted that US oil extraction in the lower 48 States would peak in the early 1970s. His forecast proved accurate and US production has declined ever since 1971.

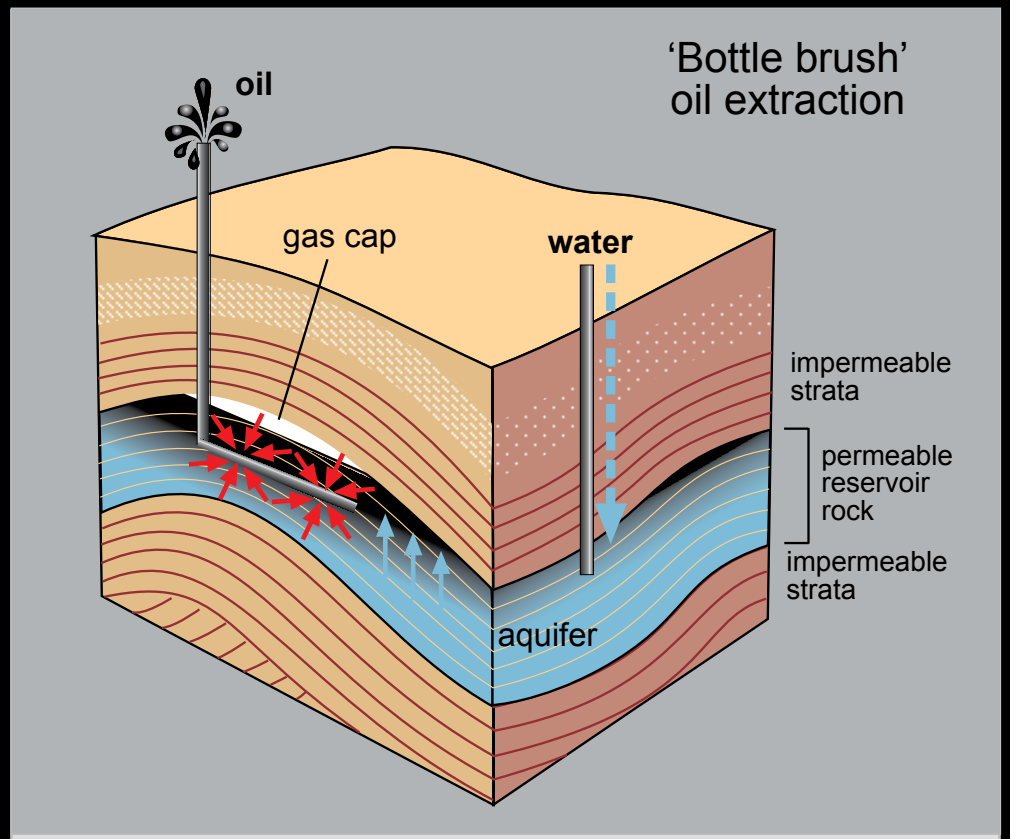
Hubbert also predicted that global oil extraction would peak around the year 2000, and if it were not for the disruption to the industry during the eight-year Iran-Iraq war, followed by the 1991 Gulf War, that forecast too, would have been accurate.

Hubbert based his predictions primarily on the declining rate of oil discovery. Despite intensive exploration and improved technology the last of the world's major oil discoveries were all made in the 1970's. Oil is now being globally consumed about four times faster than it can be found, and that discrepancy is increasing every year.

On a per-capita basis, oil production reached its peak in 1979—when the Iran-Iraq war began. It has since declined at an accelerating rate due to the continued growth of the global population.

Despite the development of sophisticated oil-search and extraction technology during the past three decades, the rate and volume of new oil finds has significantly decreased. In the 1950s each barrel of oil used in exploration and production, added about 50 barrels to the world's known reserves. That ratio is currently about 1:1 and most independent energy analysts agree that 'Peak Oil' is now upon us.

In keeping with technology's 'Faust Clause', many of the world's most productive wells are now using 'Bottle-brush' extraction methods (see diagram). This boosts their yield on a daily basis but also makes them much more prone to drying up with little or no warning. ❇



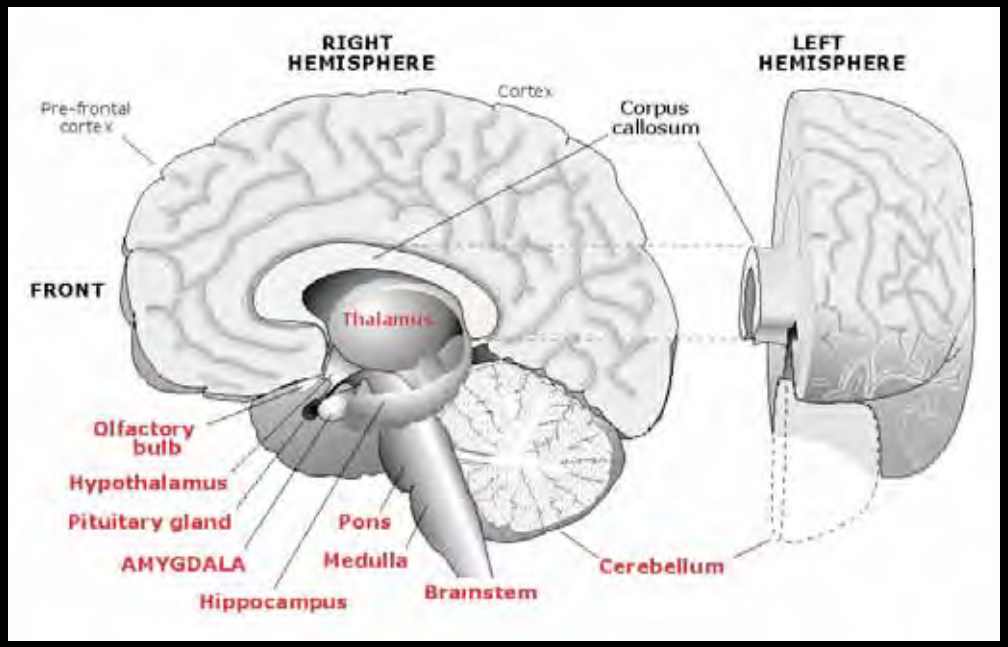
All major Saudi oil fields now use horizontal 'bottle-brush' extraction techniques and most meet their daily extraction quotas by forcing oil to the surface with massive injections of sea water—up to three times the volume of oil that flows from the pipe heads. This involves complex, expensive technology and signifies that the oil layer is no longer economically viable via vertical wells. As the aquifer swells and the oil layer shrinks however, these fields begin to yield an increasing percentage of water mixed with the oil. When this 'water cut' passes 50% the cost of extraction rises exponentially and the oil yield declines—with alarming speed

PRACTICALLY DERANGED

When hominid brains first began to bulge with new neuronal networks and their capacity to reason increased, they might well have been in danger of dulling the fast reactions and savage responses inherited from their very successful primate ancestors. Reasoned thought had to be kept separate and subordinate to the tried and true system of non-rational instinctive reactions. If they had attempted to work out and weigh up the long-term evolutionary values of alternative behavior whenever instinctive reactions were required, the time delay would, in most instances, have ensured that they not only lost all advantageous moments, but their lives as well. But so long as the capacity for rational thought remained an optional extra, the solution was both simple and practical: whenever matters affecting genetic survival arose, the genes assumed direct control and rational government gave way to genetic dictatorship.

Paradoxically, such automatic abdication of rational thought would have been especially valuable in the face of imminent destruction. If our ancestors had all turned and run whenever reason dictated that they should, then Homo DNA would have come to its very logical end in a few patches of blood-stained African dust some two million years ago. As prey animals humans were even more ill-equipped to run than they were to turn and fight. If evolution had added the leaden handicap of logic on such occasions it would have guaranteed the leopards a regular lunch of tender young humans, and none would have made it to old age. There is little doubt that during the past two million years of human evolution the cold-blooded processes of Darwinian selection would have unerringly weeded out many a deep thinker in favor of the wild-eyed fanatic—among tribal leaders especially. The clinical eye and the cool head would still have had their uses of course, but only as optional extras that could be called on to solve tactical or technical problems, and then be relegated to their usual subordinate role—just as they are today. But with mystics leading the tribe, evolution faced a new and knotty problem. How do you marry spectacularly irrational behavior with a gradually increasing capacity for rational thought, and still keep the brain running relatively smoothly?

The solution seems to have been provided by the natural physical division of the brain into two separate hemispheres. Almost all of the information that passes between the brain's two hemispheres travels via the corpus callosum. Evolution seems to have capitalised on this by making the two hemispheres responsible for very different functions, and then limiting the interplay between the two sides. A classic case of divide-and-rule. . . . (***Plague Species*** pp230-231)

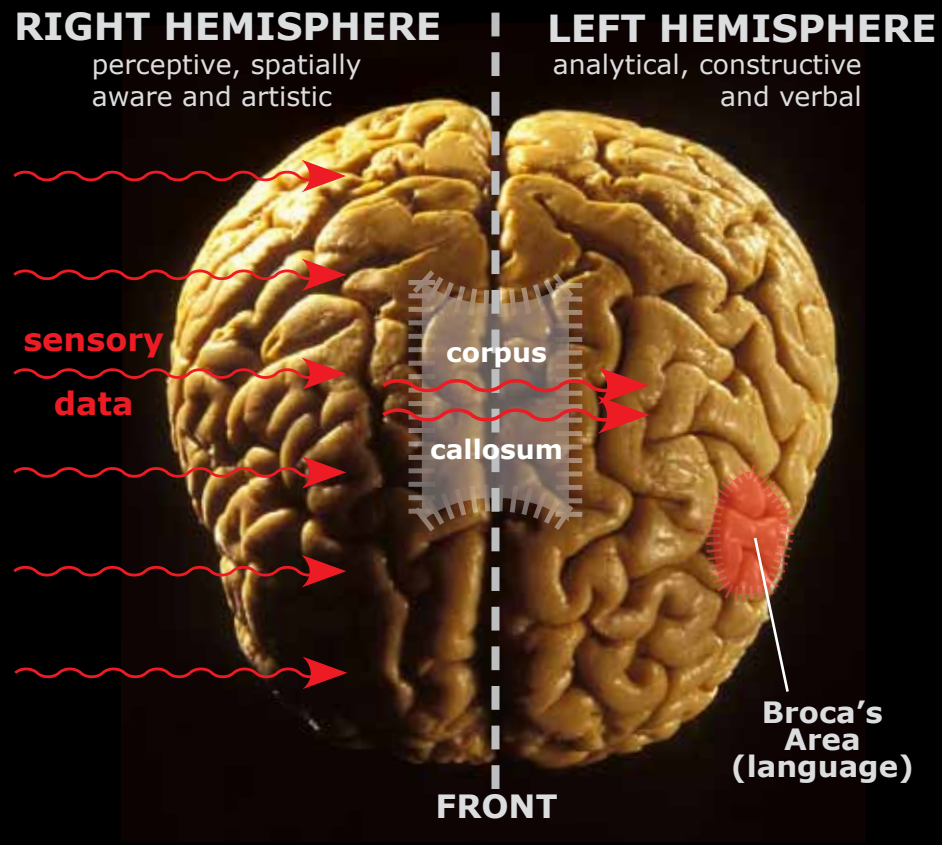


Our split brain - 1

After a long series of experiments in the 1960s with patients whose brain hemispheres had been surgically separated (by cutting the strap-like *corpus callosum* that directly links them), neurobiologist Roger Sperry found himself forced to conclude that: 'surgery has left these people with two separate minds, that is, two separate spheres of consciousness.' He added: 'This mental dimension has been demonstrated in regard to perception, cognition, volition, learning and memory.'

In most cases, severing the *corpus callosum* separated the right hemisphere from its only means of communication with the outside world, the left hemisphere's language factory known as Broca's Area. In one extraordinary case however, a split-brain patient who had sustained some left-hemisphere brain damage as a child revealed verbal competence in both hemispheres after surgery. Sperry and his colleagues were then able to communicate with each hemisphere separately, and during extensive tests designed to reveal the patient's personality, discovered that **two entirely separate, very distinct characters inhabited the two hemispheres.***

Equipped in this fashion with the capacity to operate on two levels of awareness while being 'conscious' of only one, our hominid ancestors were sitting ducks for the evolutionary sting that followed. That gap between the two spheres of human awareness left genes with precisely the loophole they needed to retain ultimate control of the body's entire communications system. If the analytical and constructive hemisphere, the left, was not at all times fully aware of the wide range of perceptive activity occurring in the right hemisphere, then here was a gap in the cortical defences through which whole truckloads of mystical nonsense might pass virtually unchallenged. . . .



Of the torrent of sensory data that enters the receptive right hemisphere relatively little is accurately transferred via the *corpus callosum* to the analytical and communicative left hemisphere. Significantly, the one area of the brain where sexual dimorphism is most evident is the *corpus callosum*. The female version is thicker and more bulbous than the male version, and has far more nerve fibres linking the two hemispheres than has the male. Consequently men have poorer communication between the left and right sides of their brain. It is as if evolution specifically widened the 'brain gap' in men to ease the birth of their elaborate mystical fantasies.

* R.W. Sperry, "Lateral specialisation in the surgically separated hemispheres." *Neurosciences: Third Study Program,* 1974, pp.5-19.

Our split brain - 2

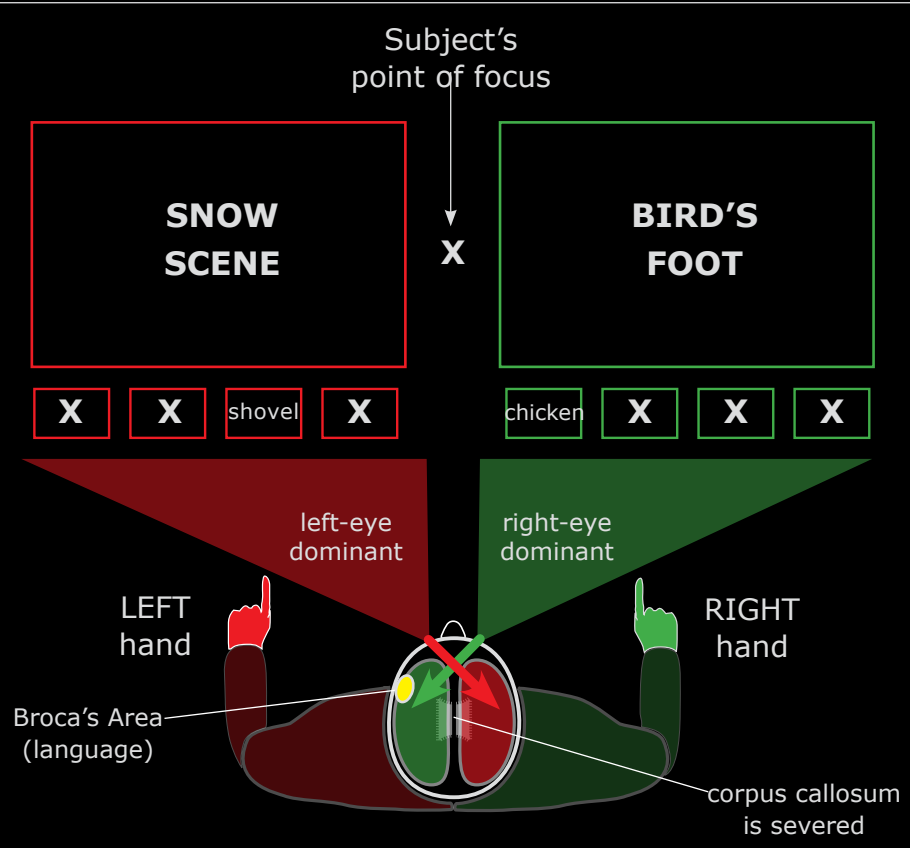
During experiments with a split-brained patient conducted in the 1970s by Michael Gazzaniga in collaboration with Roger Sperry, a picture of a bird's foot was flashed to the patient's left hemisphere via his right eye, and a picture of a snow scene was presented to his right hemisphere via his left eye. Below these images were four smaller pictures, only one of which could be readily associated with the main image. When asked to identify these connections he correctly chose a shovel with his left hand (controlled by the right hemisphere) and a chicken with his right hand (controlled by the left hemisphere). When asked to explain his choices, he responded: "Oh, that's simple. The chicken claw goes with the chicken, and you need a shovel to clean out the chicken shed."*

Gazzaniga concluded that the left brain observed the left hand's choice of a shovel—which stemmed from the right brain's nonverbal, inaccessible knowledge—and offered a fictional explanation to conceal its ignorance of the real reasons for that choice.

Further work indicates that the left-brain can influence memory—sometimes for the worse. In one study, Gazzaniga and his colleagues presented an assortment of novel pictures to the left hemisphere of split-brain patients. Where these new pictures shared elements or themes with a picture that the patients had already studied, the patients often mistakenly identified the new ones as having been seen previously.

It seems that our Broca's Area cannot abide a vacuum, and so wherever there is an information gap, it constructs a fictional narrative that might reasonably account for the body's inexplicable right-brain activity.

Here then, is the curious brain machinery that underpins our mystic visions, religious experiences and spiritual fantasies, as well as our false-memories and tiresome conspiracy theories. ❇



Each of our eyes is linked to the opposite hemisphere of the brain via a crossover of the left and right optic nerves. In similar fashion the left and right sides of the body are also linked to the opposite hemispheres of the brain. The linkage is exclusive when the corpus callosum is cut. It is important to remember that in most humans only the left hemisphere of the brain has a voice, since language is assembled in Broca's Area. Consequently, the right brain has little say in the continuous stream of propaganda that is issued, both internally and externally, by this obsessively active facility.

* Michael Gazzaniga, "The Split Brain Revisited," *Scientific American*, 1998, pp.35–39.

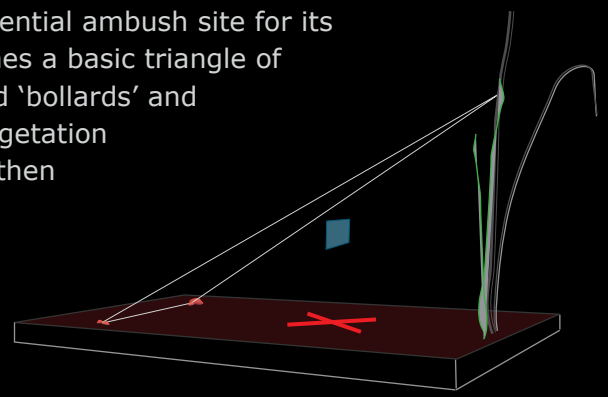
 (From pages 64, 65)

THE NET-CASTING SPIDER'S HAND-WEAPON

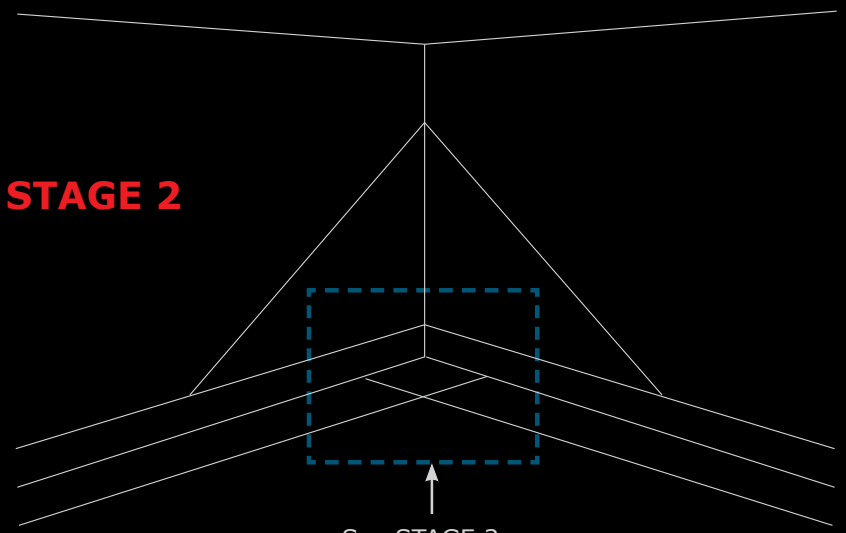
There are four major stages in its construction:

STAGE 1

This first stage begins at twilight after the spider has physically checked a potential ambush site for its suitability. It then attaches a basic triangle of strong silk to two ground 'bollards' and a convenient piece of vegetation on one side. The spider then inserts several lines of subsidiary scaffolding directly above the killing ground.



STAGE 2

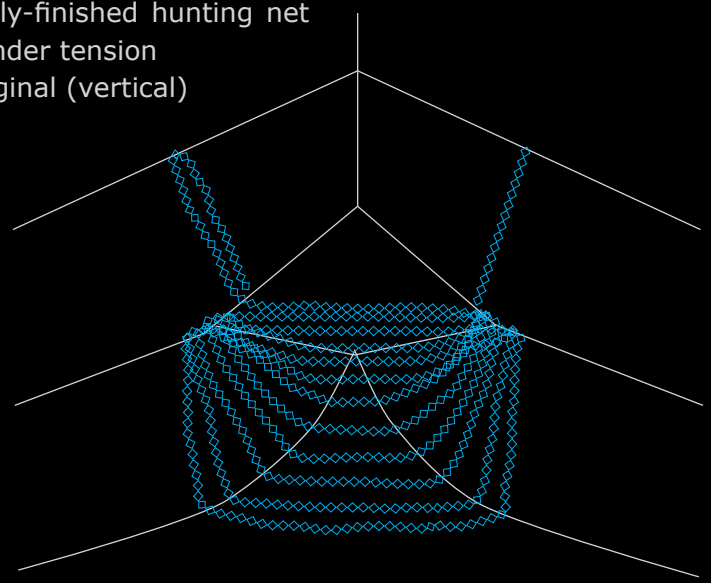


See STAGE 3

This shows the spider's subsidiary scaffolding. The blue rectangle indicates the framework into which the hunting net will be set.

STAGE 3

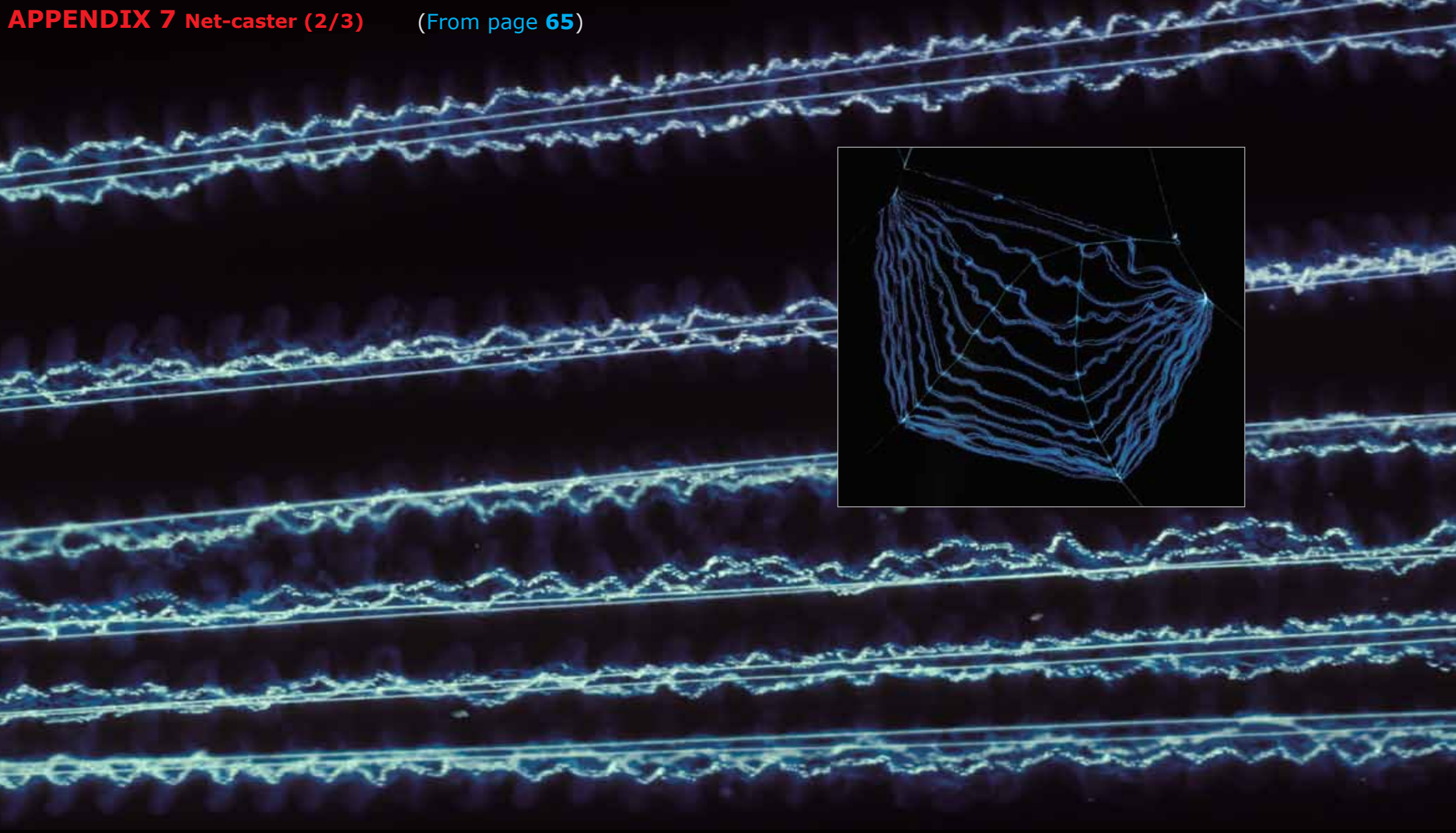
The newly-finished hunting net hangs under tension in its original (vertical) position.



STAGE 4 - Deconstruction

The spider then bites through the vertical suspension line, which collapses the net downwards, leaving it suspended only by the support lines on each side. This crucial act of deconstruction 'arms' the weapon, making it semi-mobile and able to be bounced downward when the spider lunges at its prey. It also suggests that the spider is fully aware of the nature of the structure and its components.

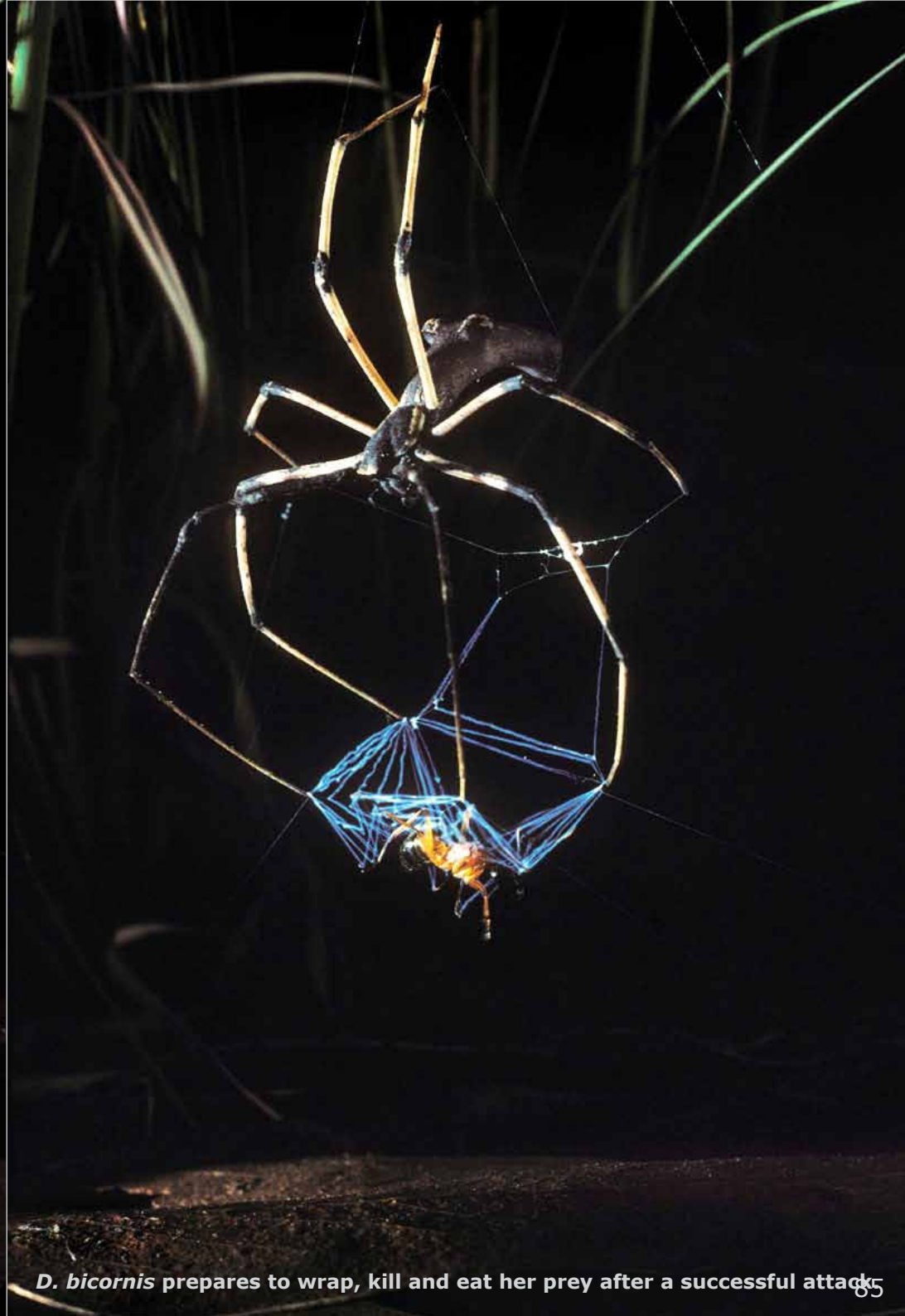
See web detail on next page



This is a magnified portion of a Net-caster's hunting net. There are three types of silk shown here: a pair of heavy silk lines, two strands of multistrand 'wool', and a thin tape made from a multitude of ultra-fine fibres. Each of the shadowy bluish loops that show on either side of the main threads reveals an individual 'pleat' that has been crimped into the 'tape' by the Net-caster's 'knitting foot'. None of the silk is 'sticky', but the fibres are so fine they will snag on the imperfections in plate glass. INSET: the finished hunting net, under tension.

See attack on next page

Deinopis bicornis **(f) prepares to attack a passing Meat ant, Sydney, NSW.**



D. bicornis **prepares to wrap, kill and eat her prey after a successful attack.**

NOTES 1:

1. (p.27) Picture of axopod microtubules courtesy of Lynn Margulis, ***Symbiosis in Cell Evolution*** (W.H. Freeman and Company, San Francisco, 1981) page 268.

2. (p.32) 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 a general guide to the gross environmental impact.

3. (pp.37, 71) Selye's original findings have since been echoed in varying degree by many other researchers, notably Dennis Chitty, in *Do Lemmings Commit Suicide? Beautiful Hypotheses and Ugly Facts* (1996), and S.A. Barnett in *The Rat* (1975). Corroboration of various aspects of GAS also comes from Scutch (1949, 1967), Brown (1953), Kalela (1954), Southwick (1955), Wynne-Edwards (1962), Christian (1961), Christian and Davis (1964), (Christian et al., 1965), and Dorner (1980). Christian and Davis were specifically testing Selye's GAS hypothesis and reported corroboration across a wide spectrum of their research.

4. (p.40) ***Burning Buried Sunshine: Human Consumption of Ancient Solar Energy***, Jeffrey S. Dukes. 2003. (University of Utah.)
http://globalecology.stanford.edu/DGE/Dukes/Dukes_ClimChange1.pdf

5. (p.41) ***Ecologists fear Antarctic krill crisis.*** Quirin Schiermeier, 2010. *Nature* 467, 15 (2010).
http://www.nature.com/news/2010/100901/full/467015a.html
ALSO: ***Dimethyl sulphide: measuring emissions from the ocean to the atmosphere.*** Zemmelink, Hendrik Jan, 2003. (University of Groningen)
http://irs.ub.rug.nl/ppn/243137931.

6. (p.48) ***Snowball Earth termination by destabilization of equatorial permafrost methane clathrate***. Martin Kennedy, David Mrofka, Chris von der Borch. *Nature,* Letter. 453, 642-645 29 (May 2008).
http://www.nature.com/nature/journal/v453/n7195/full/nature06961.html

NOTES cont:

7. (p.51) ***Improved Attribution of Climate Forcing to Emissions***. Drew T. Shindell, Greg Faluvegi, Dorothy M. Koch, Gavin A. Schmidt, Nadine Unger, and Susanne E. Bauer, 2009. *Science,* 326: 716-718
http://www.sciencemag.org/cgi/content/abstract/326/5953/716

8. (p.64) ***Increased Human Energy Use Causes Biological Diversity Loss and Undermines Prospects for Sustainability***. Carl McDaniel and David N. Borton, 2001. *BioScience*, Vol. 52 No. 10, pp.929–936. (October 2002).
http://www.csa.com/discoveryguides/ern/04jun/abstracts-f.php#c33

Selective Bibliography

This is a small selection of the more crucial sources of information and ideas that have helped to inform this essay:

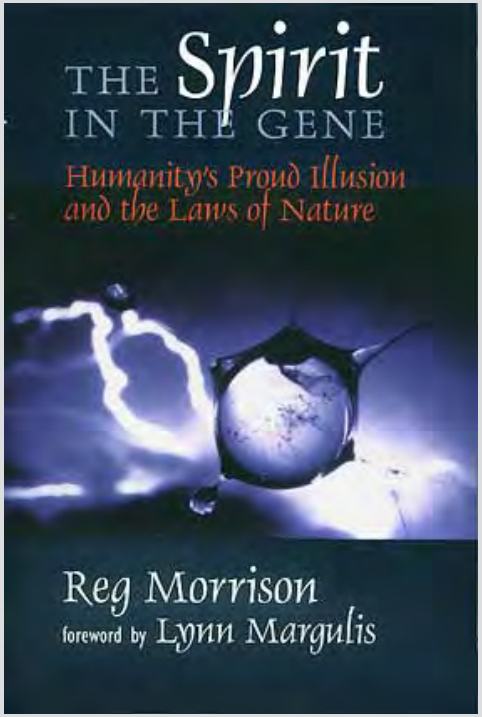
(*In alphabetical order*)

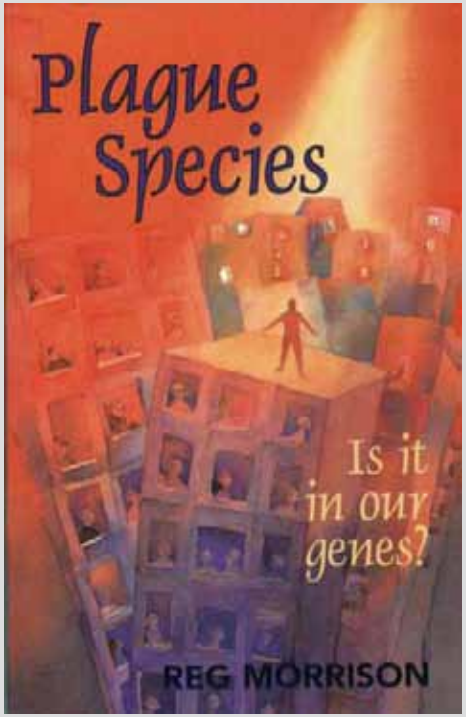
Acquiring Genomes—Lynn Margulis & Dorion Sagan, 2002.
Collapse—Jared Diamond, 2005.
Consiliance—Edward O. Wilson, 1998.
Deep Simplicity: Chaos, Complexity and...Life—John Gribbin, 2004.
DNA, The code of Life—James Watson & Andrew Berry, 2004.
Easter Island, Earth Island—Paul Bahn and John Flenley, 1992.
Extinction—Douglas Erwin, 2006.
Life Ascending—Nick Lane, 2009.
Life's Grandeur (*Full House*)—Stephen Jay Gould, 1996.
On Human Nature—Edward O. Wilson, 2004.
On the Origin of Species—Charles Darwin, 1859.
Our Ecological Footprint—Wackernagel and Rees, 1962.
Overshoot—William Catton, 1980.
Paradise for Sale—Carl N. McDaniel & John M. Gowdy, 2000.
Planetary Overload—Tony McMichael, 1993.
The Demon-Haunted World—Carl Sagan & Ann Druyan, 1997.
The Future of Life—Edward O. Wilson, 2003.
The Olduvai Theory—Richard Duncan, 2000/2009.
The Population Bomb—Paul Ehrlich, 1971.
The Ages of Gaia—James Lovelock, 1987.
The Rise and Fall of the Third Chimpanzee—Jared Diamond,1992.
The Selfish Gene—Richard Dawkins, 1976.
The Sixth Extinction—Richard Leakey & Roger Lewis, 1996.
Shadows of Forgotten Ancestors—Carl Sagan & Ann Druyan, 1993.
Symbiosis in Cell Evolution—Lynn Margulis, 1981.
What is Life?—Lynn Margulis and Dorion Sagan, 1995.

Acknowledgements

The following people have helped to guide me to reliable information and ideas over the past two decades. To them I offer my sincere gratitude for all their valuable time and trouble.

(*In alphabetical order*)
Prof. Betsey Dyer, Wheaton College, Norton MA.
Dr. David Etheridge, CSIRO, Melbourne, Vic.
Prof. Andrew Glikson, ANU Earth Science, Canberra ACT.
Dr Mike Grey, Australian Museum (Arthropods), Sydney NSW.
Dr. Arthur Hickman, Geological Survey, Perth WA.
Dr. Jim MacAllister, University of Massachusetts, Amherst MA.
Prof. Lynn Margulis, University of Massachusetts, Amherst MA.
Dr. David Sandeman, formerly of UNSW. (Arachnid brains).
Prof. Malcolm Walter, UNSW Astrobiology, Sydney NSW.





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.

Photographic prints or high resolution scans may be obtained via email application to:

regm@optusnet.com.au

Website: http://regmorrison.edublogs.org