FINGERPRINTS of the Cosmos

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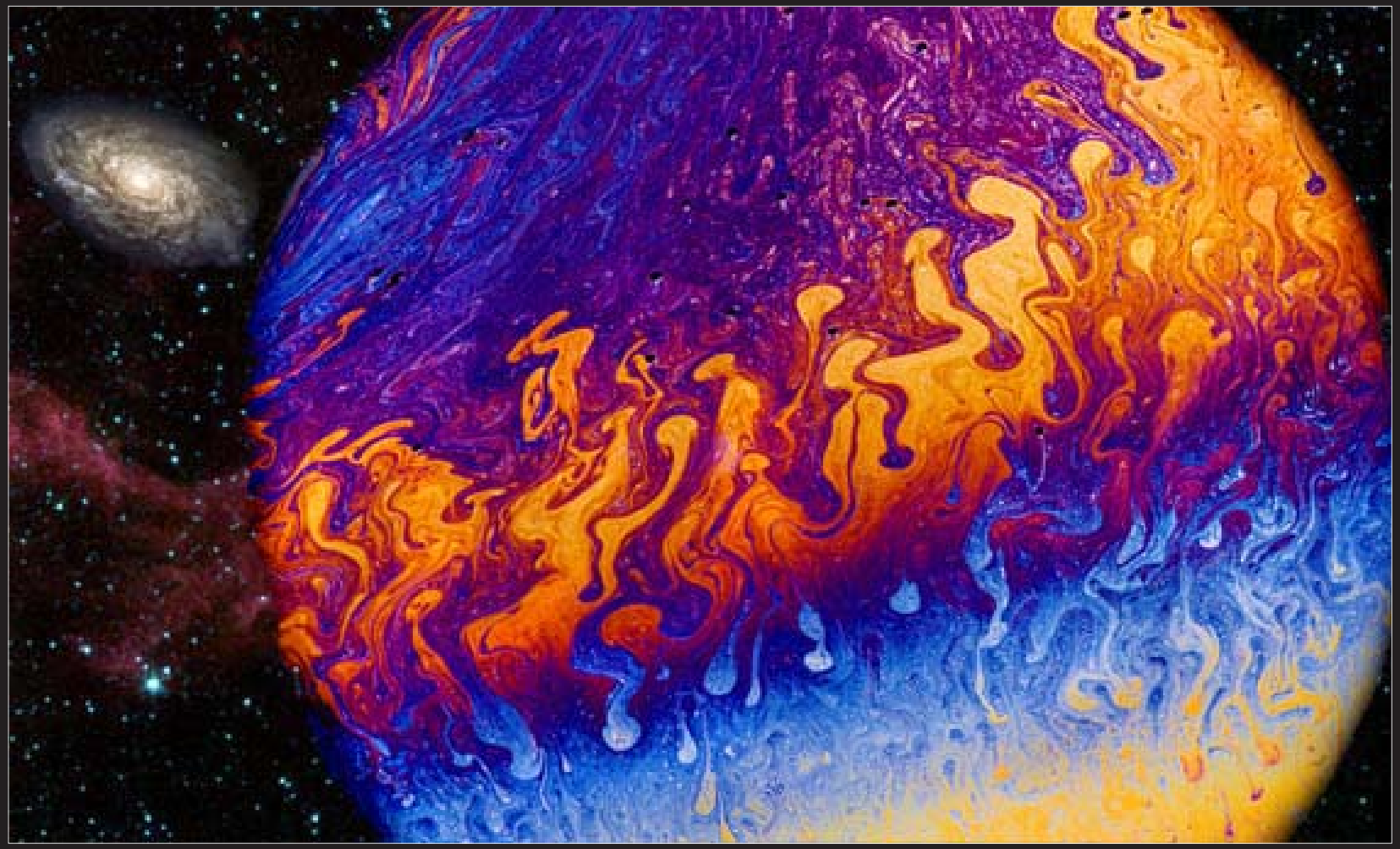
FINGERPRINTS OF THE COSMOS

'The cosmos speaks to us in patterns'

Heraclitus, 2,500 BP.



Chaotic entropy within a soap film.

Our universe is a thermodynamic system and its patterns of energy flow are inherently chaotic and fractal.* Everything that we see around us expresses this cosmic characteristic in every aspect of its existence, regardless of scale. Our brains respond instinctively to these fractal patterns and our eyes trace over them with pleasure, essentially because they are embedded in every fibre of our being. In them, we recognise ourselves.

*CHAOS THEORY, as propounded by Edward Lorenz in 1963.

The process that determines the structure of the universe and its fractal patterns of energy dispersal can be collectively described as:

ENTROPY

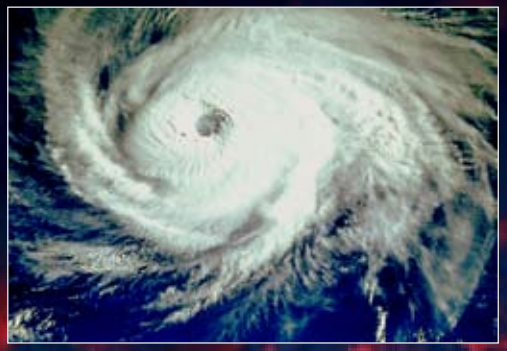
This encompasses the gradual dissipation of the energy that was originally released 14 billion years ago at the birth of the universe during the event known as the Big Bang.

Galaxies and their components are the dusty fallout from that event. They have been swept into the crevices of space-time by ripples in the remnants of Big Bang energy.

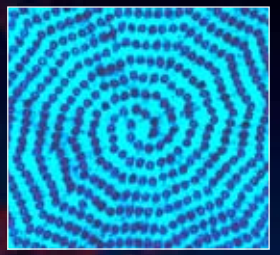
At the interface between the energy-rich surface of each cosmic body and the energy-poor matrix of space, a chaotic gradient exists. The visible expression of Earth's energy gradient is the biosphere and its biota. They represent cogs in this planet's machinery of energy dissipation, and their most visible expression is our moisture-laden atmosphere and its turbulent weather systems. These are the by-products of four billion years' metabolic activity, and as such, they are also the hallmarks of Life.

Cosmic entropy, in the form of lightning in Earth's primitive atmosphere, is believed to have been responsible for hammering together many of life's very first building blocks, the amino acids from which protein is constructed. The spiderweb on which this raindrop hangs is pure amino acid.

Whirlpool Galaxy (Hubble image, NASA)



Typhoon, NASA satellite image

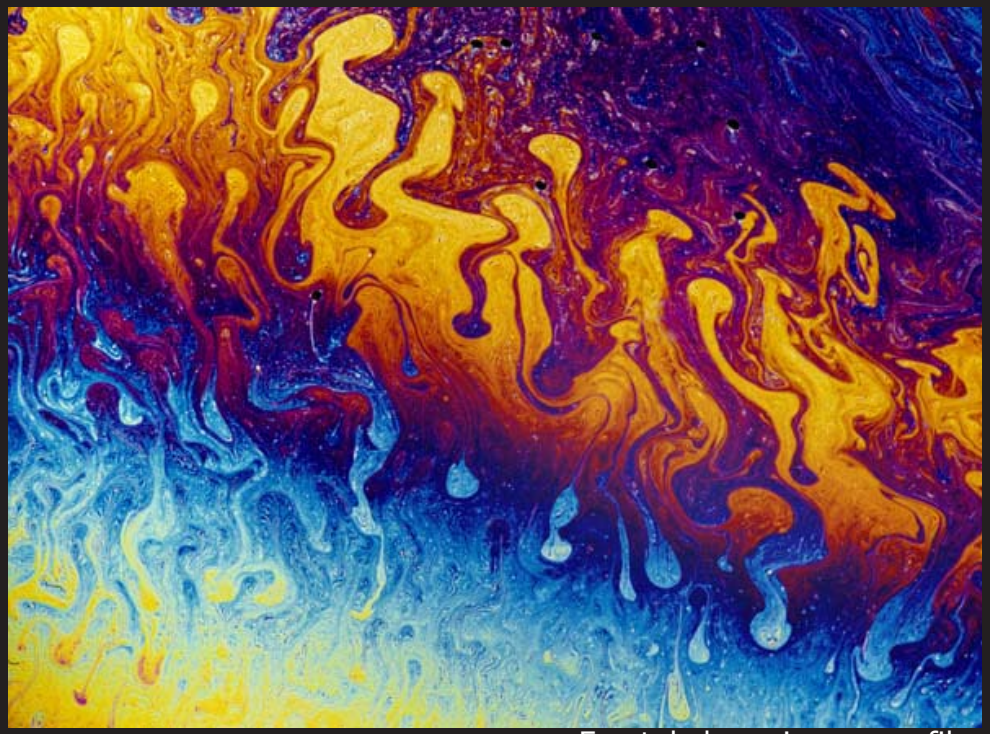


Micro-tubules,
within a cell.

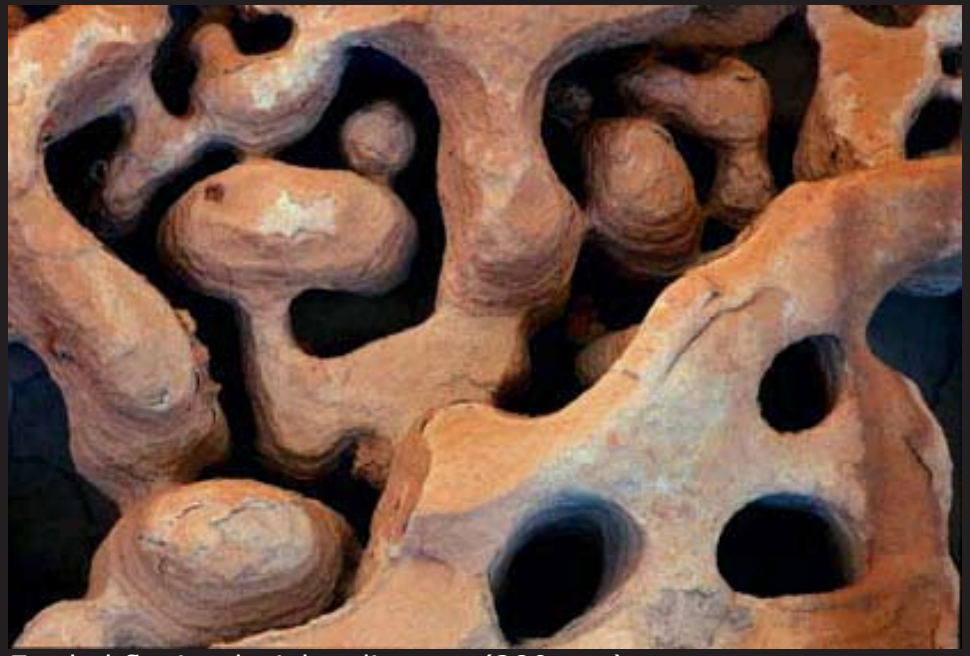
Cosmic entropy takes many forms, but it is most flamboyantly displayed in Earth’s weather systems and cloud patterns. The key characteristic of entropy is the repetition of its basic structures at all scales of magnitude from the cosmic to the micro-cosmic, from galaxies to intra-cellular structures. In short, it is FRACTAL.

The laws of entropy that shape the universe are typically expressed in spheres, spirals and S-shaped curves known as sigmoids. These consequently reccur in all cosmic structures, from galaxies to soap bubbles, from the hearts of cabbages to the brains of kings. As the 14-billion-year-old echoes of the Big Bang, they will continue to shape planets like ours until its last kinetic gradient disappears.
These are the fingerprints of our entropic cosmos.

Galactic dustcloud.
(Hubble image, NASA)

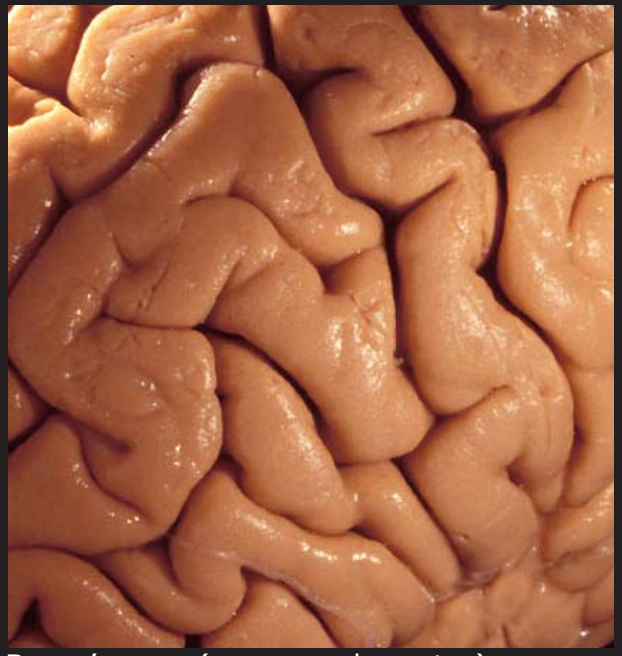


Fractal chaos in a soap film



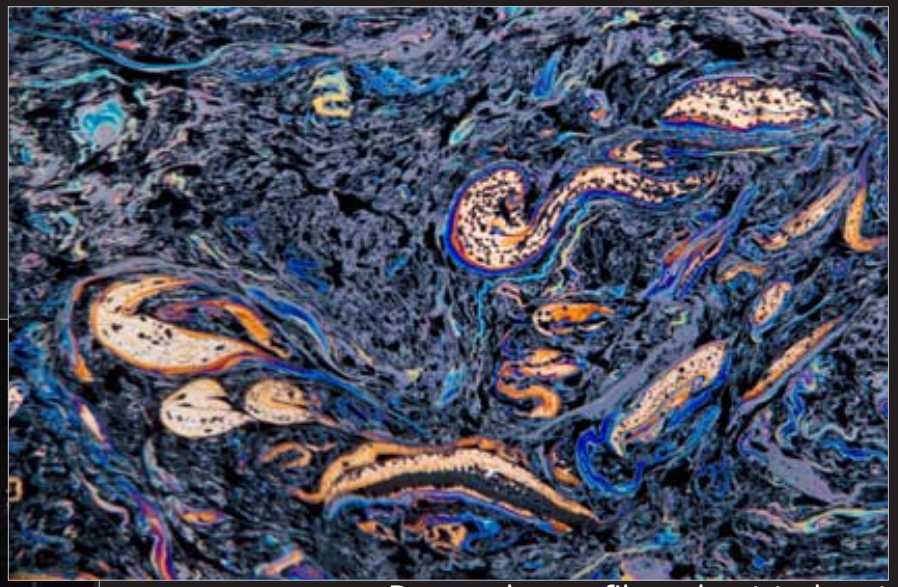
Eroded fluvio-glacial sediments (280myo)

Red cabbage



Broca's area (our speech centre)

A stellar remnant (BELOW) displays its cosmic relationship to the stringy sheet of soap film that marks its final moments of existence (RIGHT). The visual difference between them springs largely from the fact that the stellar remnant has three visible dimensions, the soap film, only two.

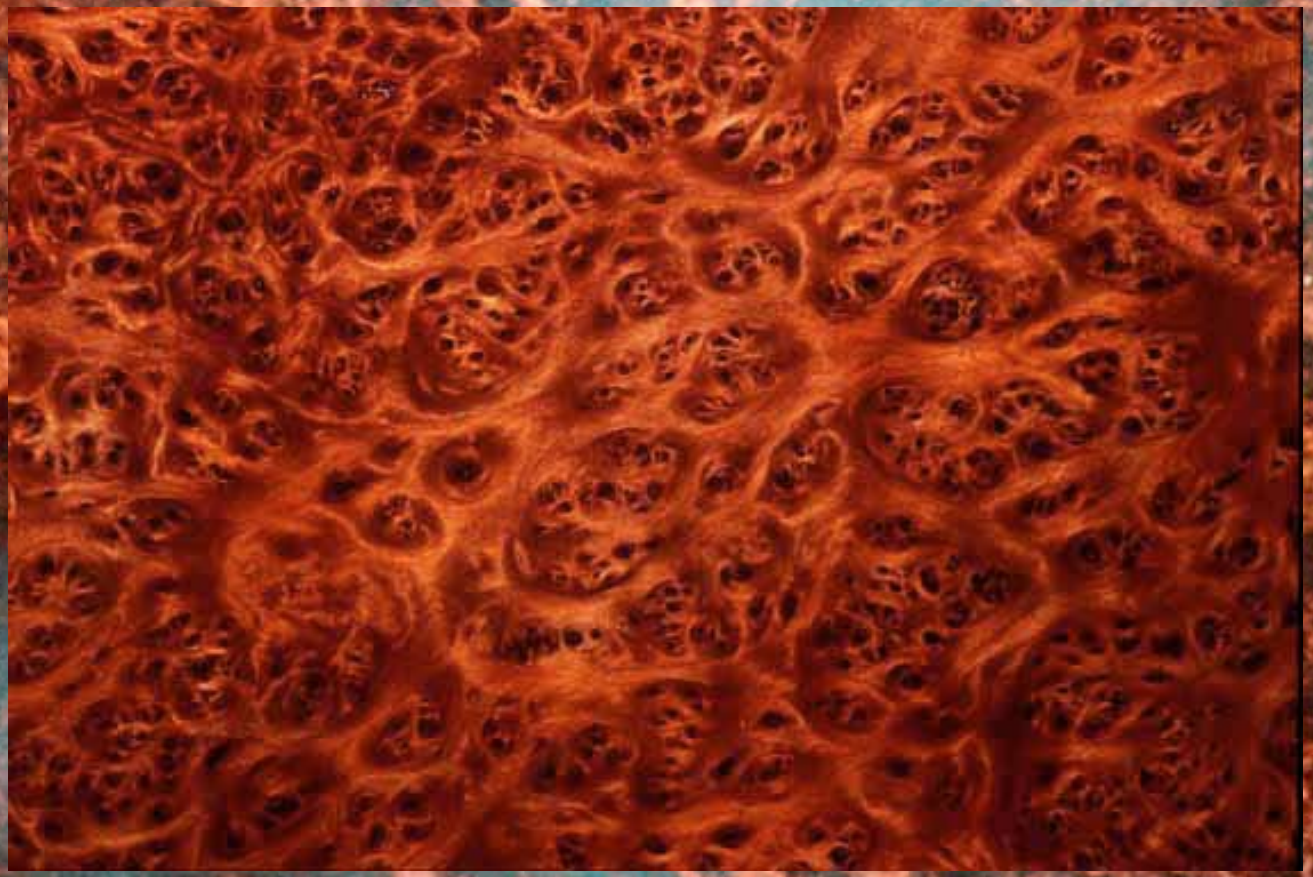


Decayed soap film, about to burst

LEFT: This digital image, taken by a camera mounted on NASA's Hubble Space Telescope, shows delicate filaments of gas and dust that are sheets of debris from a stellar explosion in a nearby galaxy known as the Large Magellanic Cloud.

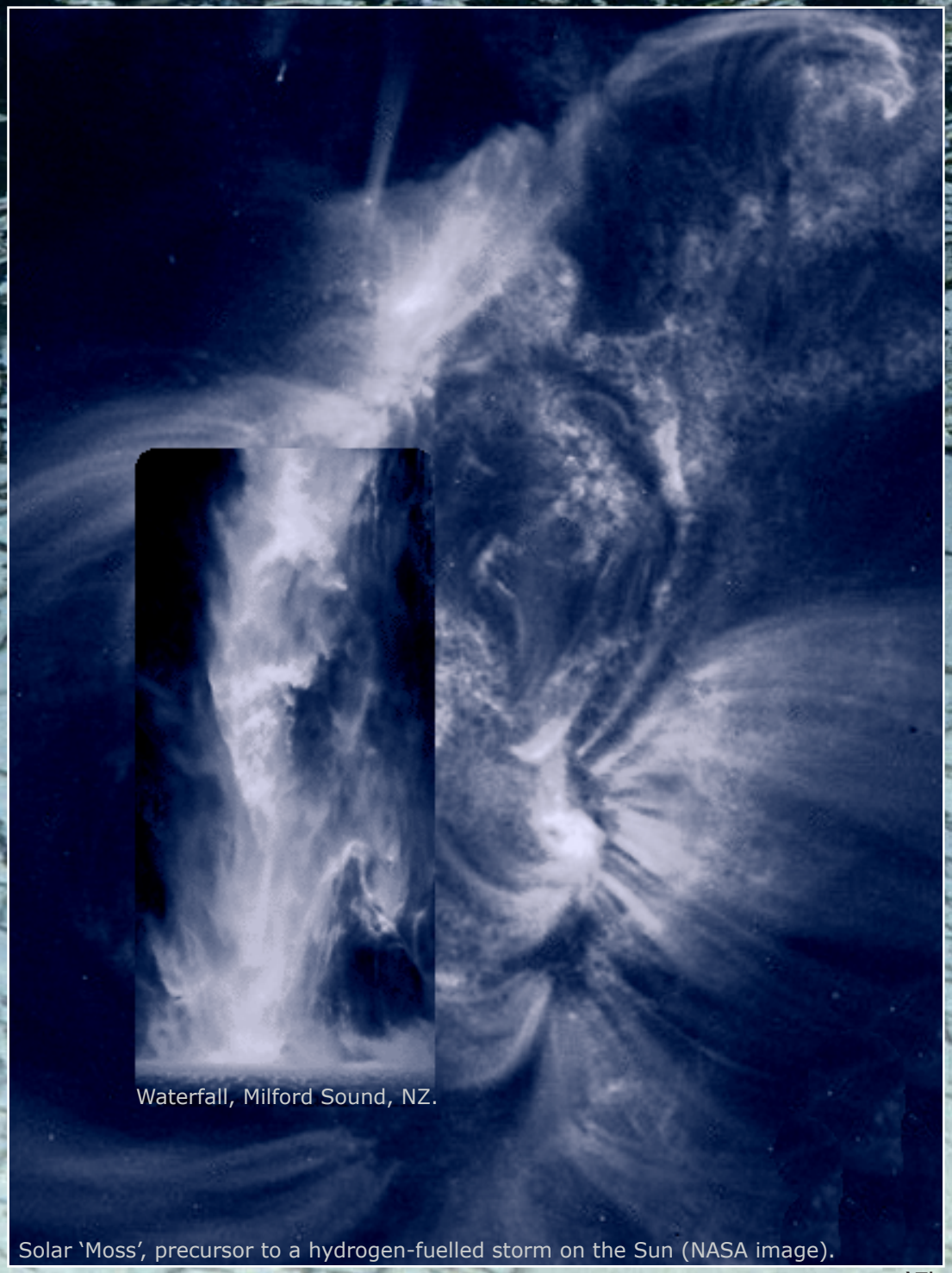
NEXT PAGE: Hydrogen in action. The background image shows the Crab Nebula, the remains of a supernova , a by-product of hydrogen fusion deep in the Sun's interior. The inset image shows a layered tangle of vascular bundles in a cross section of a burl cut from a New Zealand Kauri. Plant growth is fuelled by hydrogen that plants extract by dismembering hydrogen's oxide, H_2O, with the aid of sunlight.

HYDROGEN IN ACTION



BACKGROUND: Crab Nebula, a by-product of hydrogen fusion (NASA). INSET: Kauri burl in section, a cancerous outgrowth fuelled by hydrogen harvested via photosynthesis.

HYDROGEN IN ACTION



Waterfall, Milford Sound, NZ.

Solar ‘Moss’, precursor to a hydrogen-fuelled storm on the Sun (NASA image).

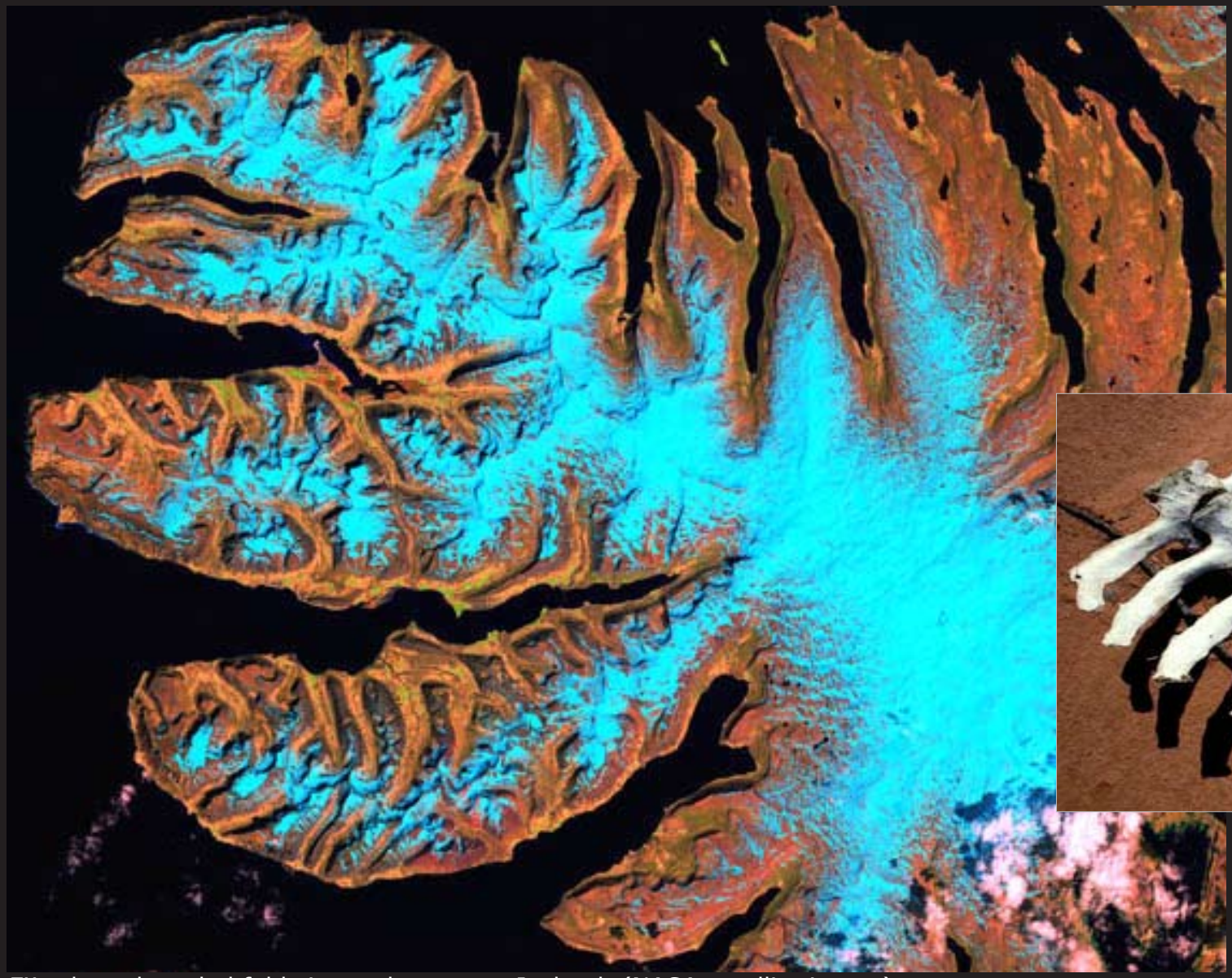
‘Flowstone’, shaped by hydrogen’s oxide, water. NZ.

In order there is Chaos:
in Chaos there is order.

Computer-generated fractals. (Peter F. Allport)

Fractal growth in a foliose lichen
(with reproductive spore cups),
Cradle Mountain, Tasmania.

ENTROPY: CHAOTIC AND FRACTAL



Fijords and eroded folds in north-western Iceland. (NASA satellite image)

The chaotically fractal nature of entropy typifies all cosmic structures, both animate and inanimate. When prolonged entropy unveils more durable structures beneath the surface, these structures too, frequently display a striking similarity.

Cow spine, Strzelecki Desert, SA.

The cosmos leaves its clearest imprints on our planet in the form of impact scars such as Gosse Bluff in central Australia. This crater-like structure is the eroded remains of a deep crustal bruise left by the impact of a giant meteorite some 142 million years ago. Such impacts are accurately replicated every time a raindrop hits a body of water. Gosse Bluff represents the base of the rebound splash shown in the final frame of the series at right. The up-turned collar of hard marine sandstone that now forms the walls of the amphitheatre originally lay more than two kilometres underground. The modern stucture has been unearthed by massive erosion.

Aerial: Gosse Bluff, Central Australia (NT).

EROSION IS FRACTAL

RIGHT: This scalloped escarpment is the eroded edge of a massive anticlinal fold in central Australia. It originally formed the bed of a sea corridor bisecting the continent more than 600 million years ago. Aboriginal legends name this fractally scalloped escarpment the 'place of the Dancing Women'.

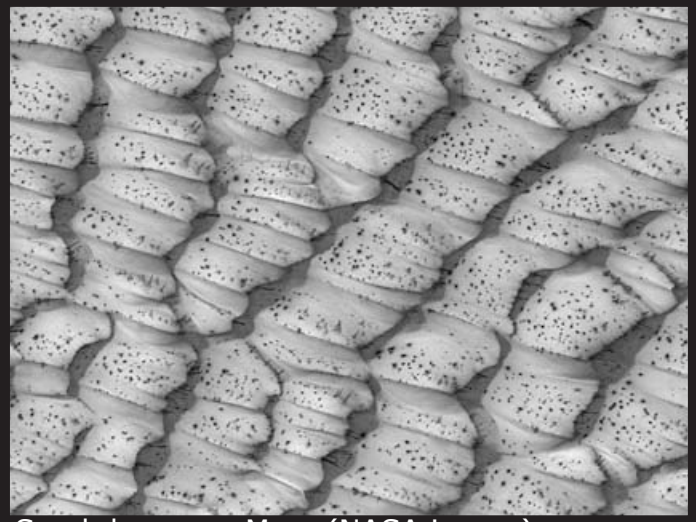
'Dancing Women', western MacDonnell Ranges, NT.

Fluvio-glacial strata, Poole Range, WA.

LEFT: Looking like the fossilised scales of a gigantic reptile this thick sheet of unlayered sediment was dumped by a torrent of meltwater pouring from beneath a glacier in the ice-capped southern Kimberleys some 270 million years ago.

THE PRODUCTS OF EROSION ARE FRACTAL

Ilmenite and rutile sand, Fraser Is. QLD.



Sand dunes on Mars (NASA image)

Dry sand weeps down damp dune-face, Wilson’s Prom. VIC.

Rock engraving, Pilbara, WA.

Aerial: L. Lefroy, WA.

The fractal patterns that characterise the eroded landscapes of Australia's arid zone are echoed in the petroglyphs (LEFT) that were chipped into the rocks by the land's first human colonists more than 20,000 years ago.

Strzelecki Desert, SA.

LIFE TOO, IS FRACTAL

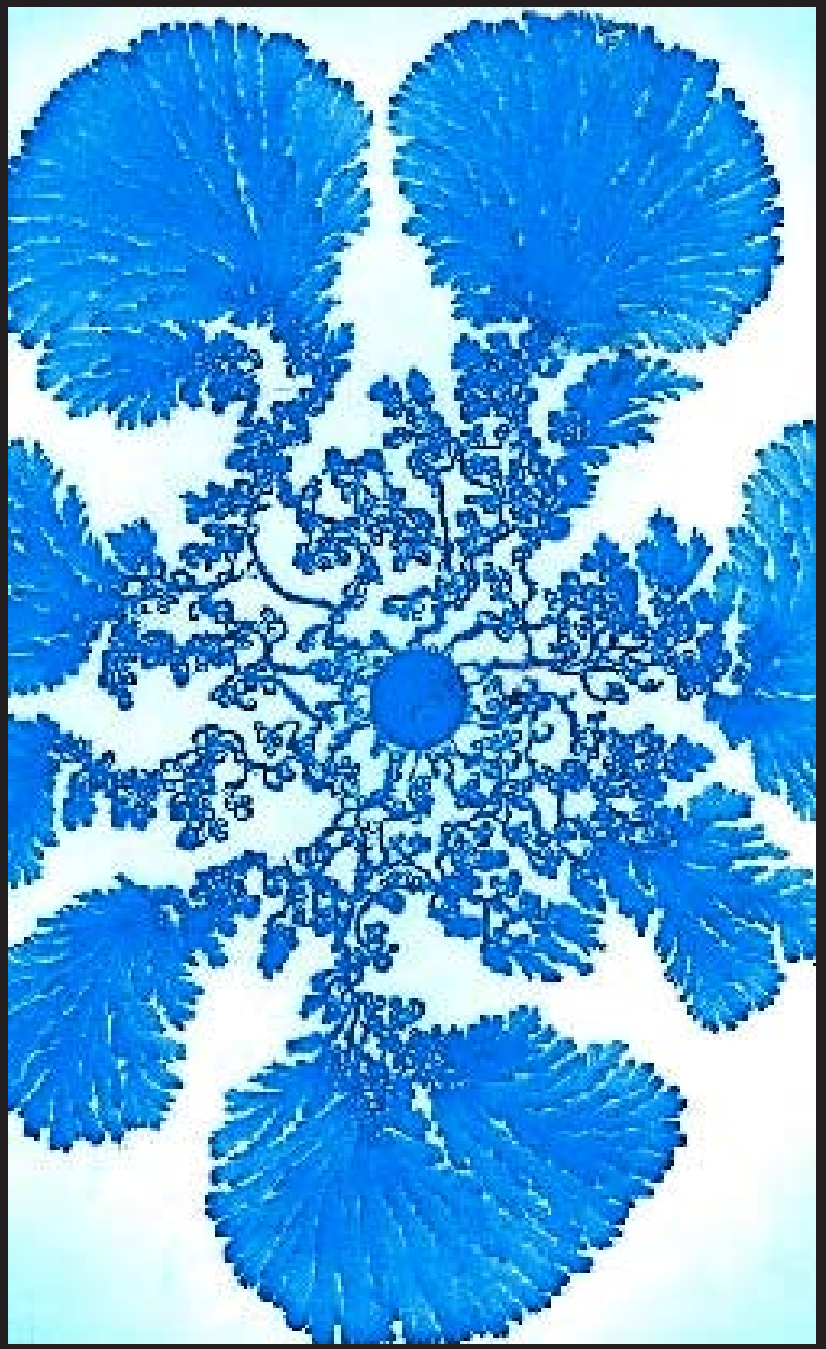
Life is explicitly fractal, right down to its molecular base. Genetic material replicates continuously, enabling species to grow and reproduce with astonishing fidelity.

RIGHT: This is the growth pattern of colonial bacteria. (Photo: Eshel Ben-Jacob, Tel Aviv University, Israel.)

LEFT: A computer generated fractal pattern.
(Photo: Peter F. Allport.)

BELOW: Seen from the air, coral reefs typify the chaotic and fractal nature of all life.

Aerial: Great Barrier Reef, QLD, Australia.



Colonial bacterium *Paenibacillus dendritiformis.*

RIGHT: Even life's oldest tangible traces are fractal. Buried and fossilised during a process of branching, these layered deposits were left along an Australian shoreline almost 3.5 billion years ago by colonies of photosynthetic marine bacteria.

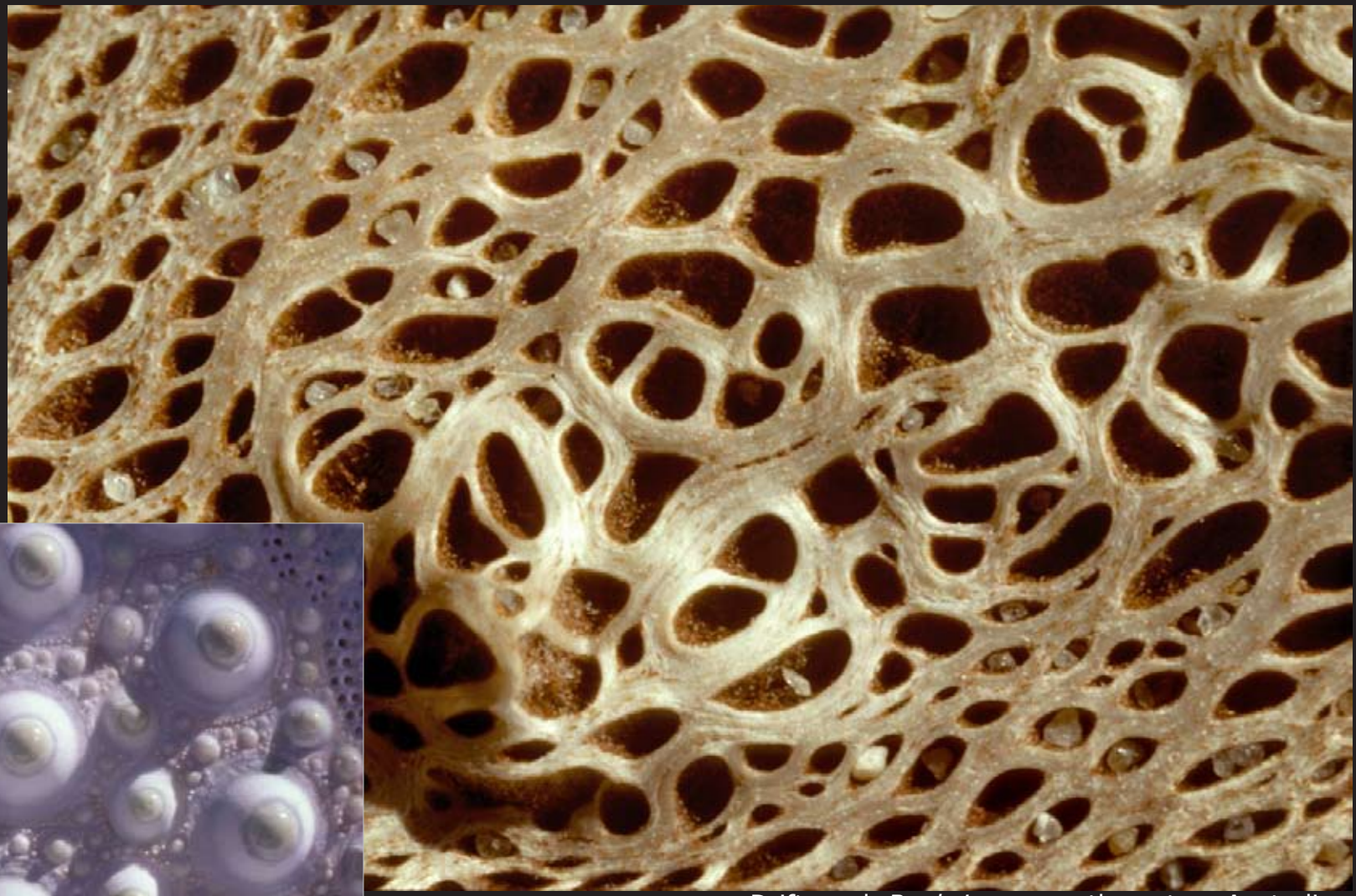
BELOW & BOTTOM RIGHT: The stromatolites that line the shores of Shark Bay on Australia's west coast are being built by descendants of the bacteria that built the fossil.

Fossil stromatolites, Pilbara, WA.

'Live' stromatolites, at high tide, Shark Bay, WA.

'Live' stromatolites at dawn, low tide, Shark Bay, WA.

RIGHT: These patterns were created by a network of vascular bundles that formed the trunk of a banksia tree growing beside an estuary in south-eastern Australia. They distributed water and nutrient throughout the tree in the years before it died and became driftwood.



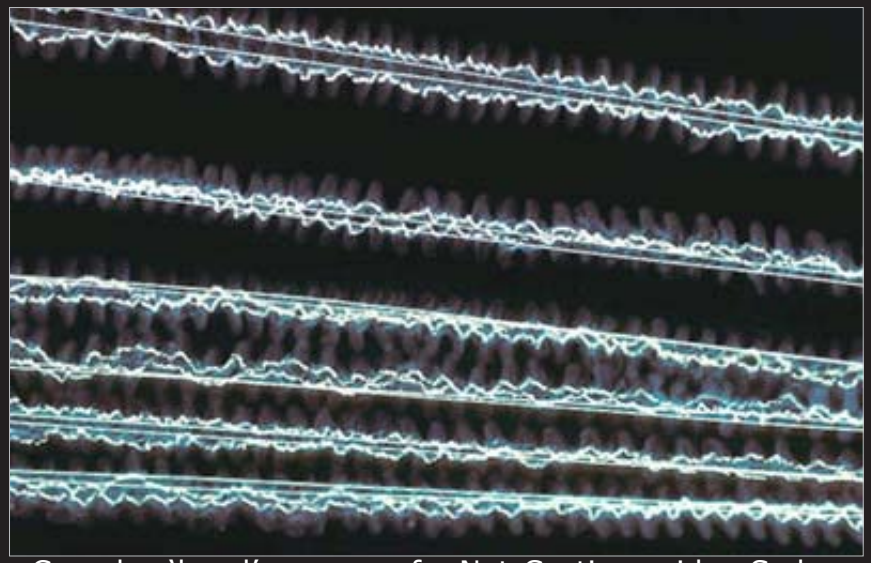
Driftwood, *Banksia sp*., south-eastern Australia.

Skeleton of a sea urchin (Echinometra mathaei), Australia.

LEFT: The orderly array of ball joints that once attached a forest of spines to the skeleton of an echinoderm epitomises the fractal nature of all organic deposition, and thereby, of all metabolism and growth.

Life is Fractal

Tadpoles in eggmass of Brown-striped frog, Sydney.



Complex ‘hand’ weapon of a Net-Casting spider, Sydney.

Wings of a phasmid (leaf-insect), Sydney.

A peacock’s tail.

Sori on fern frond (Cyrtomium falcatum).

Wing feathers of a Great Argus pheasant (*Argusianus argus*).

Bones are the internal deposits of calcified ‘waste’ that accumulate in the bodies of vertibrates when nutrient is extracted from food. Such deposition, like that of erosion sediment, is inherently chaotic and fractal, and occasionally rippled like beach sand (RIGHT).

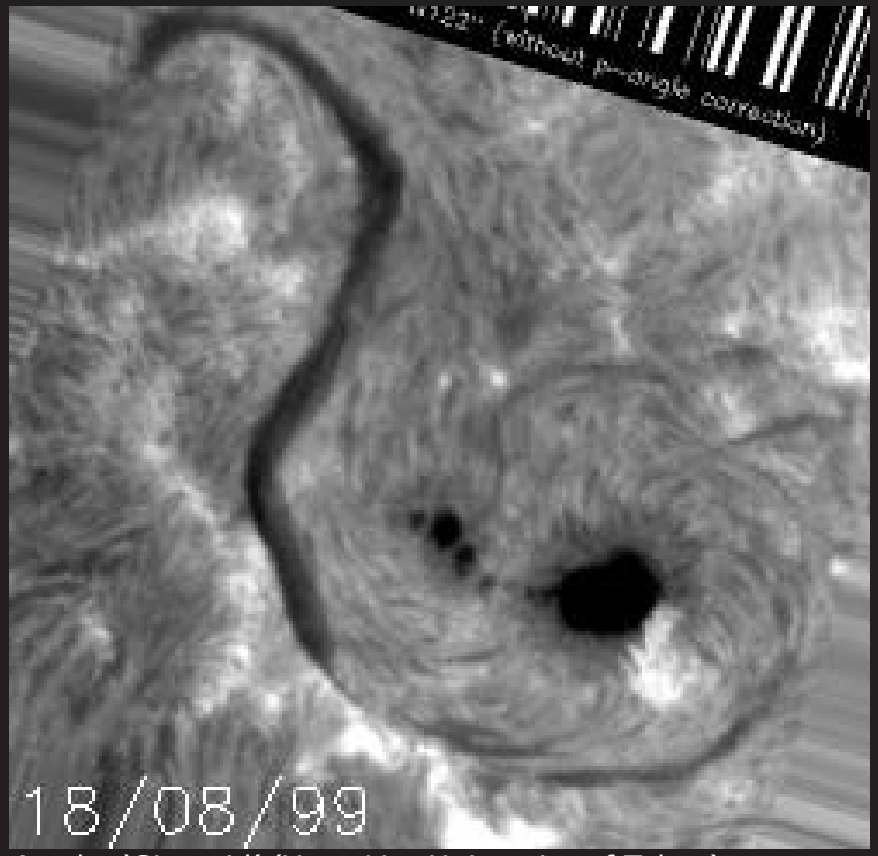
Bone deposit in a fish head.

Skeleton of a Kangaroo, Strzelecki Desert, SA.

The patterns of energy flow that determine the pigmentation in a tiger's fur are fractally related to those that determine the flow of spring-water over black ilmenite and rutile sands on the beaches of Fraser Island and Cooloola in south-eastern QLD. Such powerful flows of kinetic energy are inherently Chaotic, fractal and sigmoidal …

SIGMOIDS

A ‘sigmoid’ is so called because it resembles the ‘S’ shape of the Greek letter ‘sigma’.
BELOW: Sigmoidal disturbances on the surface of the Sun commonly preceed the gigantic eruptions of solar energy known as sunspots.
RIGHT: The uncurling of a new fern frond similarly heralds an eruption of metabolic energy from within the body of the fern.



A solar ‘Sigmoid’ (Yang Liu, University of Tokyo).


King fern (*Angiopteris evecta)*, Fraser Island, QLD.

Tree-fern fronds (*Cyathea sp.*) uncurling on a digital background by S. Geier (http://www.sgeier.net/fractals/indexe.php)

BRANCHING SIGMOIDS

A common hallmark of Earthly entropy appears in the dendritic (branching) patterns that characterise powerful energy flows in environments of grossly different density and texture. The energy flows themselves are invariably expressed in sigmoidal curves. Similarly dendritic patterns characterises every nerve, blood and lymph system in the human body.

Aerial: Tidal drainage, Talbot Bay, Kimberley, WA.

Nullarbor Plain, WA.

Dead mulga woodland, Finke, NT.

Fungal hyphae beneath Eucalyptus bark.

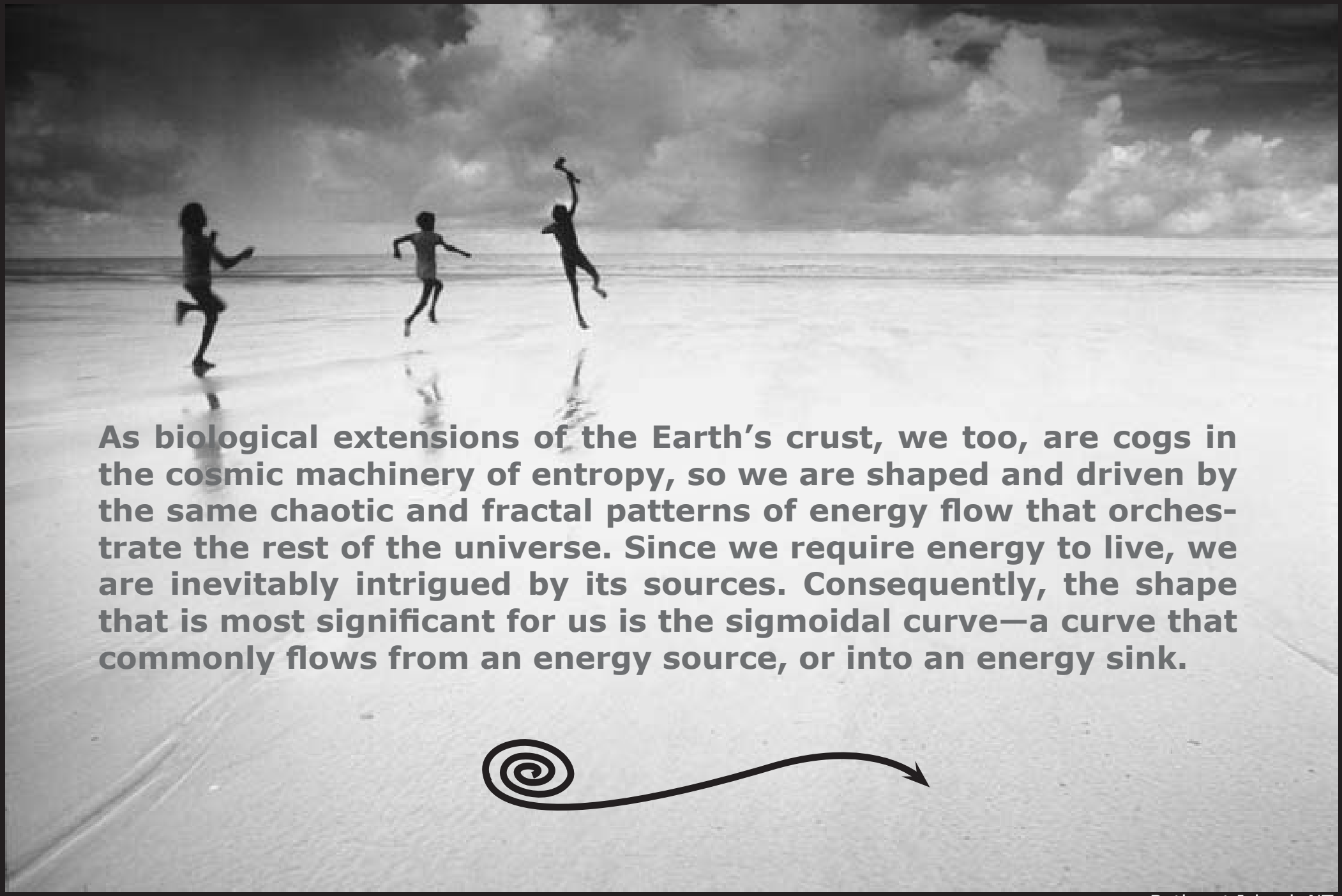
Tree-like tentacles of a holothurian, Great Barrier Reef, QLD.

Perhaps the most elegant example of sigmoidal growth in the plant world is displayed by the sensuously muscular Gimlet Gum (*Eucalyptus salubris*), which is endemic to the Kalgoorlie-Norseman region of Western Australia.

THE HUMAN FACE OF COSMIC ENTROPY

Of fractals, sigmoids, and our genetic attraction to them.

Skull: *Homo habilis* (KNM-ER 1470), Africa.
Brain: *Homo sapiens* (not to scale).



As biological extensions of the Earth's crust, we too, are cogs in the cosmic machinery of entropy, so we are shaped and driven by the same chaotic and fractal patterns of energy flow that orchestrate the rest of the universe. Since we require energy to live, we are inevitably intrigued by its sources. Consequently, the shape that is most significant for us is the sigmoidal curve—a curve that commonly flows from an energy source, or into an energy sink.

Bathurst Island, NT.

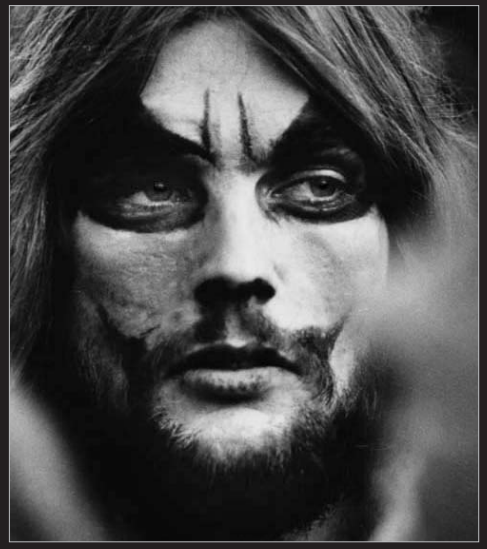
Since smooth sigmoidal curves invariably signify powerful flows of kinetic energy, they coincide with nourishment and growth and are inherently attractive to human genes.

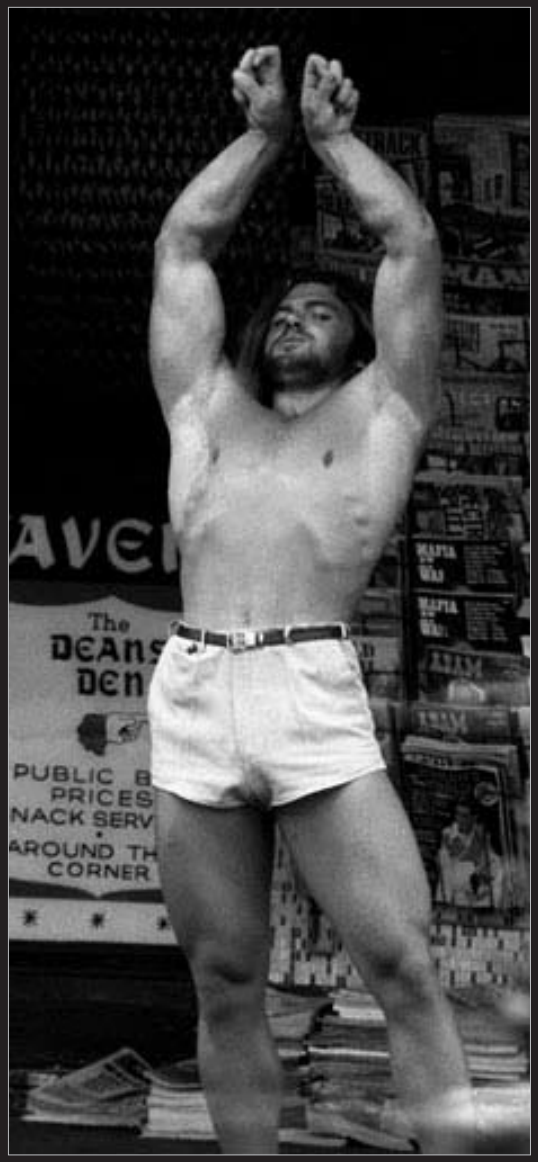
Dani, Sydney.

Our devotion to the sigmoid begins very early … and lasts a lifetime!

As far as adults are concerned the sigmoid is the source of all physical beauty. It resides in lips, eyes, ears, hair, feet, hands, torso and limbs.

And wherever such curves appear in sexually mature bodies they not only signify health and vitality, they double as the icons of reproductive viability—they are 'sexy'.





Sydney

Ruth, Perth

Sydney

Trevor, Perth

Sylvia, Perth.

And when we try to ornament our sigmoidal bodies in order to enhance our tribal status and reproductive viability, our genes instruct us to 'choose' spiral, circular and sigmoidal decorations.

Kintore, NT.

Reveller, Sydney.

'Butterfly', Perth.

Maree, Perth.

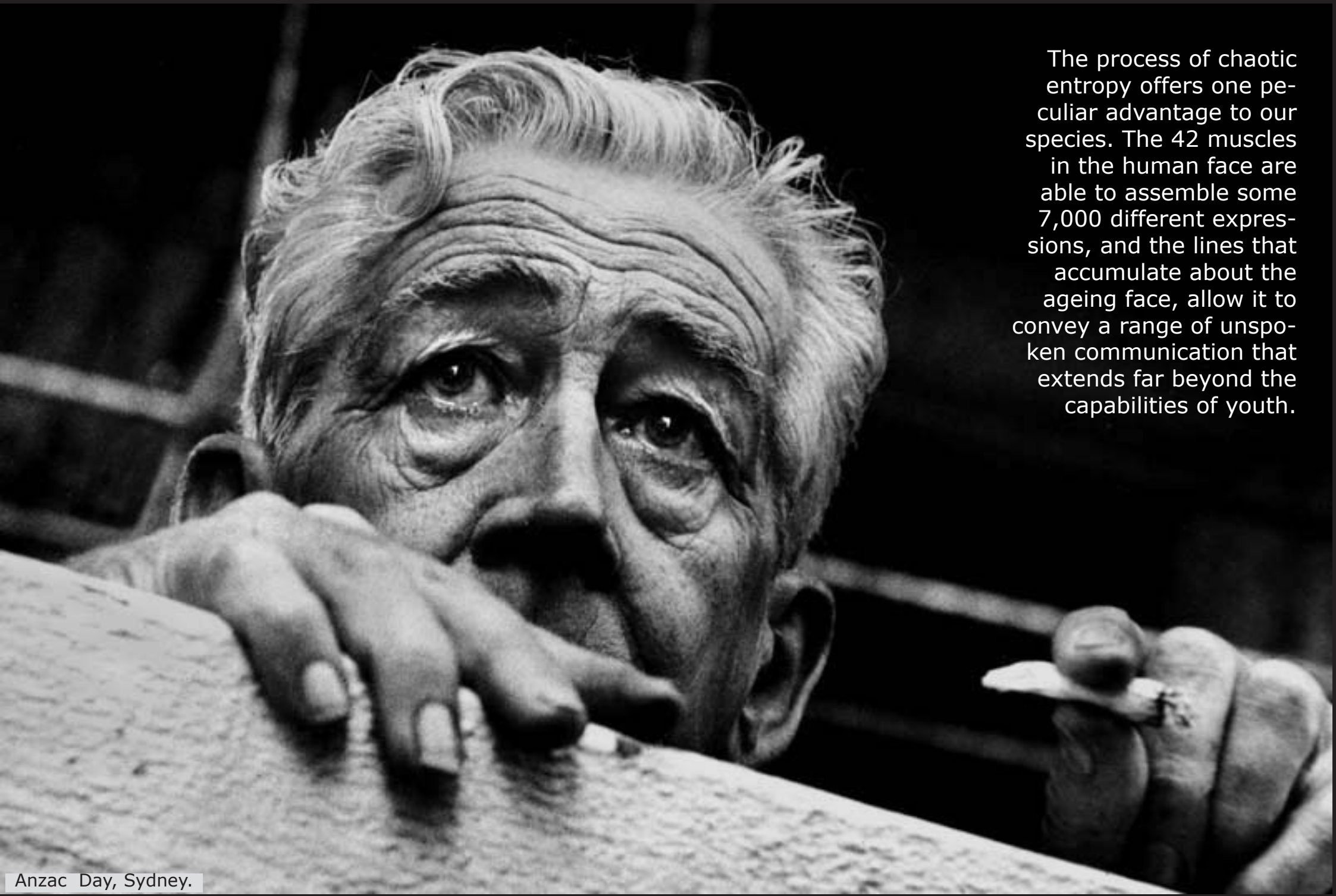
Linda, Perth.

THE HUMAN FACE OF CHAOTIC ENTROPY

As entropy begins to take its toll, however, the smooth sigmoidal curves of youth shrivel into leathery folds, the skin becomes a chaotic moonscape of creases, craters and scars, and the skeletal framework begins to show.

A farmer, WA.

The human face of entropy



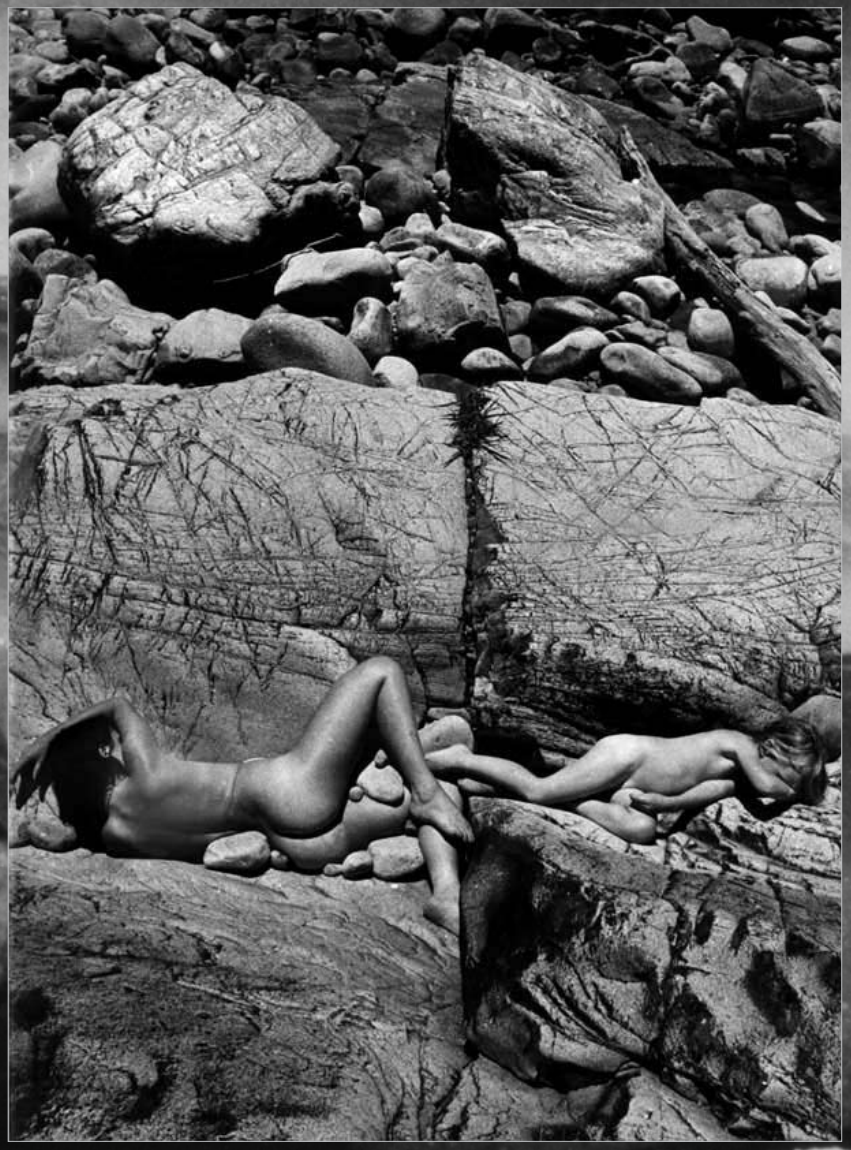
The process of chaotic entropy offers one peculiar advantage to our species. The 42 muscles in the human face are able to assemble some 7,000 different expressions, and the lines that accumulate about the ageing face, allow it to convey a range of unspoken communication that extends far beyond the capabilities of youth.

Anzac Day, Sydney.

The human face of entropy

Annie, Wilcannia.

Born of the ash of burnt-out stars, and shaped and driven as we are by the molecular code of DNA,
we are intimately related to all life, to the sea that nurtured it,
and to the rocks that gave it refuge.



END

Moonlight on Bunker Bay, WA.

CHAOTIC FRACTALS

All thermodynamic entropy is inherently chaotic and fractal and is determined by repetitive feedback (iteration) within kinetic energy gradients.

Fractal patterns have been recognised as a primary characteristic of the natural world for at least 2,500 years (see Heraclitus quote, p.2). Nevertheless, such patterns were not explored in much detail until the early 1960's when, with the aid of computers, meteorologist Edward Lorenz began to analyse the iterative and fractal nature of weather patterns. He presented his research in 1963 in a short, little-noted paper entitled "Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?". Lorenz' proposition, which later became widely acclaimed as Chaos theory, has also become known as the Butterfly Effect.

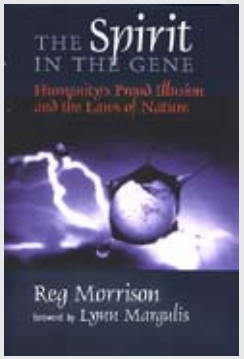
Extensive research has since revealed chaotic 'order' in such diverse phenomena as the folds in filo pastry, the dripping of taps and the beating of hearts. (Precisely regular heartbeats signal a life-threatening lack of bodily feedback: chaotic heartbeats, though slightly irregular, tend to be synonymous with good health.)

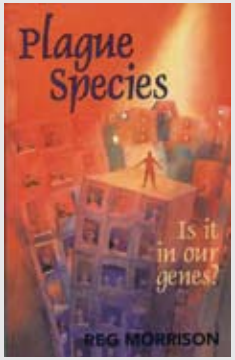
For those seeking more information on chaos and fractals:

http://www.imho.com/grae/chaos/chaos.html
http://math.rice.edu/~lanius/frac/
http://images.google.com/images?q=mandelbrot&hl=en
http://www.peterallport.com/

Biographical note

Originally a West Australian newspaperman, Reg Morrison is now a Sydney-based writer-photographer who, for the past 25 years, has specialised in environmental and evolutionary matters.
His latest book, ***Australia's Four-Billion-Year Diary,*** compresses the evolution of the continent, its plants and animals, into twelve 'monthly' episodes, and is essentially designed for High School use. (Sainty & Associates, 2005)





Reg's other recent book, published in 2003 by New Holland, Sydney, under the title ***Plague Species: Is it in our Genes?,*** summarises the massive impact that humans have had on the biosphere, and explores the evolutionary origins of the behaviour that produced this impact. It was originally published in 1999 by Cornell University Press, New York, under the title ***The Spirit in the Gene.***

Other books by Reg Morrison:

Australia, Land Beyond Time, New Holland Publishers, 2002
(original title: ***The Voyage of the Great Southern Ark***, 1988).
The Great Australian Wilderness, Phillip Mathews Publishers, 1993.
Australian's Exposed, Paul Hamlyn, Sydney, 1973.

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