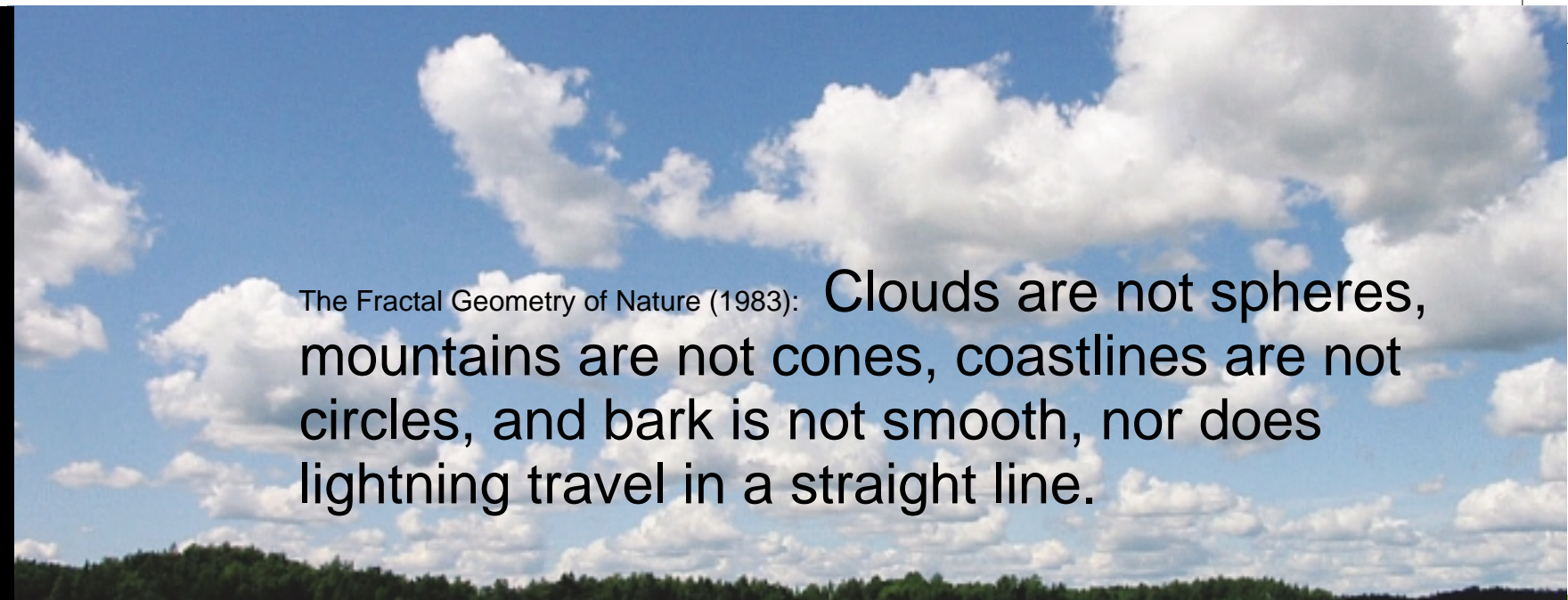
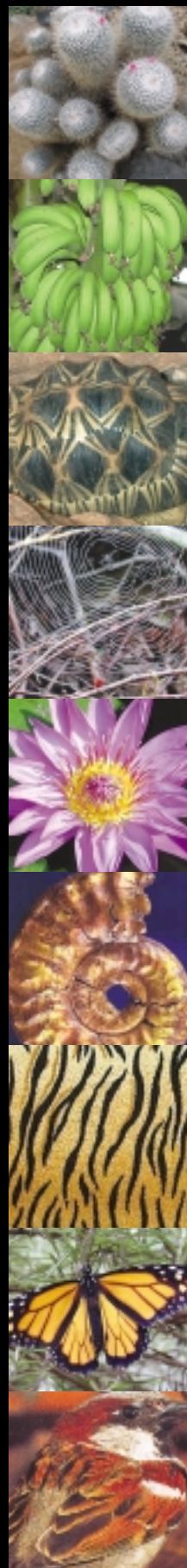


In nature, one can find numerous examples of astonishingly complex patterns or actions that with closer inspection turn out to be interactions of a large number of relatively simple actions or units, rather than single, highly complicated ones. For example nervous systems, multicellular organisms, even insect societies, all can be characterized by this behavior. Typical to all these examples is that even if the actions and structure of a single unit seem fairly simple, the interactions of multiple units can form highly complicated and unpredictable entireties and behavioral models. The interactions tend to emerge in collective phenomena that can be described only at higher levels than those of the individual units –

the whole is more than the sum of its parts



The Fractal Geometry of Nature (1983): Clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line.

A FRACTAL VIEW OF THE WORLD

magnify a mandelbrot...



a pattern...

and magnify...



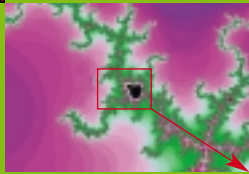
within a pattern...

and magnify...



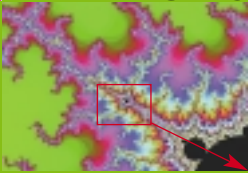
within a pattern...

and magnify...

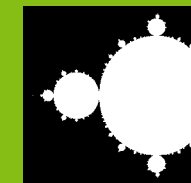


within a pattern...

and magnify...



.....



THE MANDELBROT SET

THE MOST COMPLEX MATHEMATICAL OBJECT EVER INVENTED

All this is got by the ridiculously simple formula: $z \rightarrow z^2 + c$. " \rightarrow " means "iteration", the feedback process where the end

result of the last calculation becomes the beginning constant of the next. In other words the result of $z^2 + c$ becomes the z in the next repetition. So if say $z=2$ and $c=3$, the result of the first iteration would be $7 (2^2 + 3)$ and so on. For fractals, we use only complex numbers. It is only when millions of calculations are mechanically performed by a

supercomputer and plotted that the Mandelbrot set is revealed. The order is of a strange and beautiful kind, containing self-similar shapes over an infinite scale. That means millions and millions of images in one figure!

And all this by just an equation!

Magnified picture of a brocoli



within a pattern...

Mandelbrot coined fractal from the Latin "fractus", corresponding to the verb "frangere" meaning "to break", "to create irregular fragments". He has shown mathematically and graphically how nature uses the fractal dimensions and what he calls "self-constrained chance" to create the complex and irregular forms of the real world.