mathematics in nature

photographs by simon williams

Leonardo Fibonacci

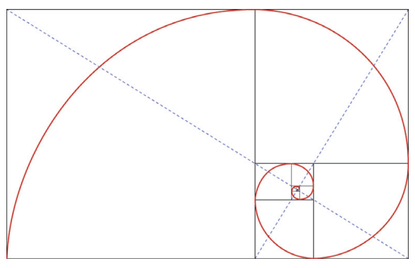
The Fibonacci Sequence is a series of numbers developed and introduced to the West by the Italian mathematician Leonardo Fibonacci in his 1202 book Liber Abaci although the sequence was known by mathematicians in the Arab world and ancient India.

The Fibonacci numbers are Nature's most common numbering system. The sequence is found throughout the natural world including the rate of reproduction of rabbits (the original study by Fibonacci), human bone structure and body proportions, the logarithmic spirals of shells, spiral arrangements of leaves on a stem, and the number of petals, sepals and spirals in flower heads during their development. The heads of sunflowers or daisies, as classic examples, are arranged in two sets of spiral rows, one curving to the left and the other to the right (both conforming to the sequence).

Plants use this system to grow in the most efficient way. In flowers the sequence is believed to optimise exposure to dew, rainfall and sunlight and ensure optimum ‘packing’ so each seed has enough space to develop. Growth patterns in stems are arranged to gain a similar advantage and maximise speed of growth. Leaf arrangement, or phyllotaxis, may be related to maximizing the space for each leaf or the average amount of light falling on each one. In the case of close-packed leaves in cabbages and succulents the correct arrangement may be crucial for availability of space.

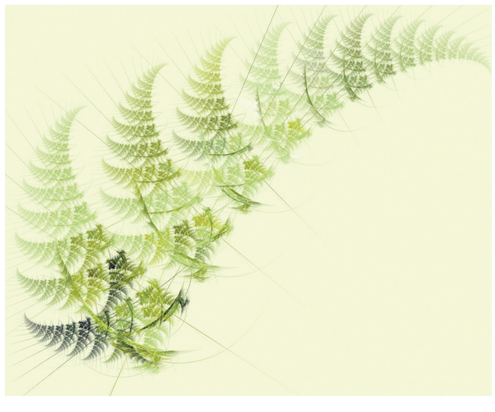
Even a tiny advantage could aid domination over many generations.

The Fibonacci sequence begins 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89... by adding two consecutive numbers you find the next in the sequence. After 13 any number divided by the previous one will give a value of close to 1.62 – the Golden Mean, first studied by the ancient Greeks in Geometry. “Golden proportions” are seen in this exhibition in the logarithmic spiral growths in contemporary mollusc shells and fossils going back millions of years - a curve which crosses the axes at the Fibonacci numbers. The spiral part crosses at
1, 2, 5, 13, etc on the positive axis, and 1, 3, 8 etc on the negative axis.



golden spiral – where squares define the radii of the circles

The Fibonacci sequence is a simplistic fractal. Fractals exhibit the property of self-similarity - an object's component parts resemble the whole and vice versa. The result of each cycle
of mathematical calculation is the input value for the next. Fractals can be computer processed to produce purely computer-generated ferns. These can be directly related to the characteristics of ferns in nature. The smallest part of the fern resembles the whole and vice versa.



computer-generated fractal fern

Nature’s designs have been appropriated to create aesthetically pleasing results in architecture, music, art and craft since the renaissance.

It is difficult to say how we define something as beautiful, though clearly we find certain mathematical proportions pleasing to us. Medieval artists and scholars considered the Golden Mean to be the most aesthetically pleasing of any ratio. Consequently it can be seen in the dimensions of many medieval buildings, the work of countless great painters of the period and up to the present day in the work of many contemporary artists and makers.

This exhibition shows some common striking visual examples of Fibonacci sequences, fractals and other number patterns. If you wish to find out more about everyday mathematics and plant patterns then please look at the books on display and pick up a list of websites to investigate further.

All images are for sale and printed, mounted and framed to archival standards. I am a South West based photographer frequently working with conservation organisations to encourage access and understanding of the natural world.

View these images online after the exhibition on **www.southviewimages.co.uk**

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