Patterns in Nature

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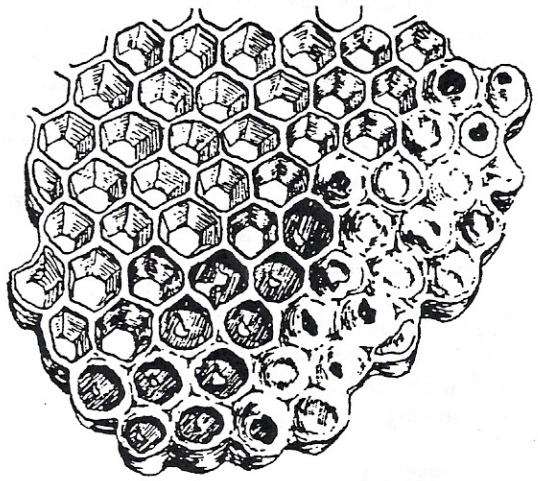
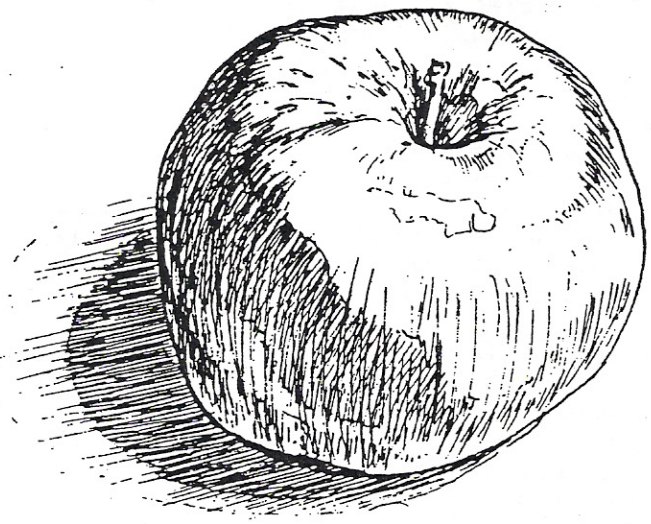
The permaculture principle of observing and replicating patterns in nature can become a fascinating study—and a life-long one. Here is a short outline of the primary patterns that occur in nature. These patterns are about forms in space; timing and rhythms influence them as well, but as my observations are part of a life-long study, I have not yet had enough opportunity to research the time dimension!

This synopsis follows the outline from Peter Boyle's wonderful book, *Patterns in Nature* (see references), with a few additions.



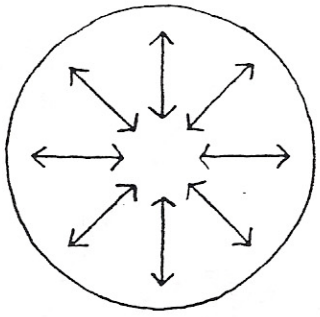


Sphere: expansion and contraction

Pattern of Perfection

Shapes: Sphere, Hemisphere, Dome

Purpose or Function: The sphere is a balance between expansive and contractive, outward and inner forces. Spheres provide the least amount of surface area for the most volume; this shape minimizes heat loss.



Examples in Nature: Planets, stars, drops of water, radiolarians, volvox algae, diatoms, eyes, eggs, seeds, cherries, crabapples, squash, pumpkins, breadfruit.

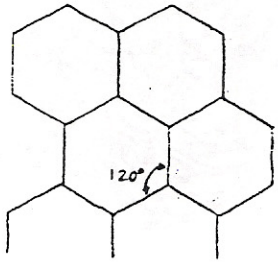
Associated Mathematical Terms: Volume = 4/3 r^3; Surface area = 4 r^2

Examples in Garden and Permaculture Design: circle gardens, solar umbrellas, geodesic domes.

Patterns of Packing & Cracking

Shapes: Polygon, Nets

Purpose or Function: Three-way joints with shared partitions minimize surface area required to enclose the same amount of volume. This shape saves space, material, energy, and creates the shortest path (besides a line); it also provides a rigid structure.



Hexagon: 120°

Examples in Nature: soap bubbles, ice crystals, honeycombs, corn kernels, turtle shells, snake skin scales, basalt columns, cilia struts, bird bones, network of veins in plants.

Associated Mathematical Terms: hexagon: 120° angles

Examples in Garden and Permaculture Design: hexagonal spacing of plants in Biodynamic systems; triangular spacing of seeds or plants; storage

Patterns of Growth

Shapes: Spiral, Helix

Purpose or Function: Spirals add size without changing the shape. They uniformly fill a space and maximize the amount of material within it. The ability to contract like a spring adds length without adding width. "Spirals are found where harmonic flow, compact form, efficient array, increased exchange, transport, or anchoring is needed" (Mollison, p. 83).

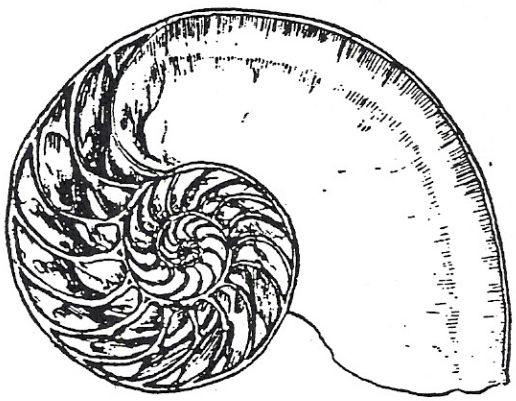
Examples in Nature: spider web, mollusk shells, sea shells, horns, composite florets, cacti, fern fronds, vine

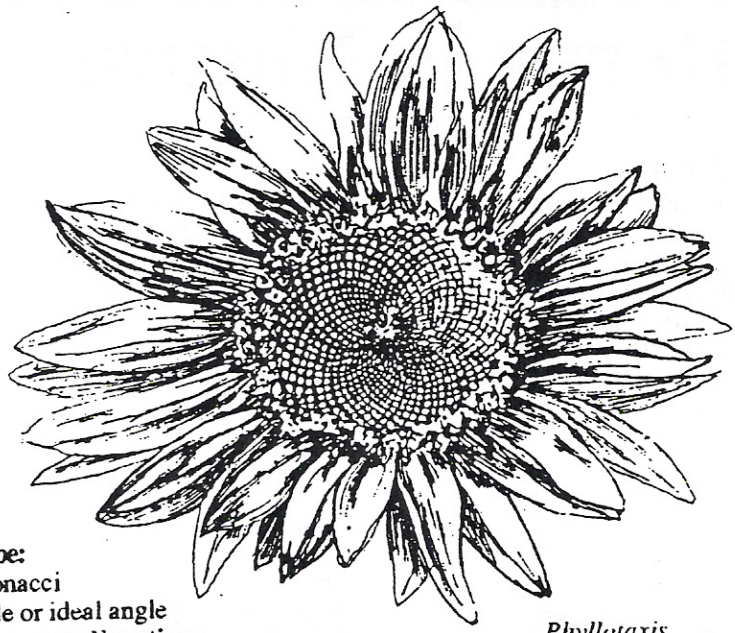
Logarithmic spiral

Archimedean spiral

Illustrations by Lisa Wittrup

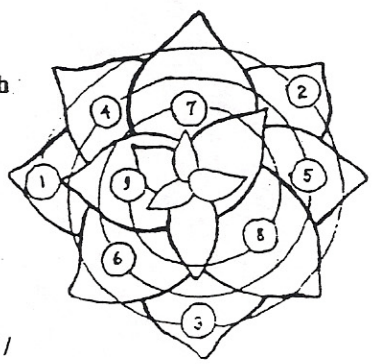
tendrils, pine cones, pineapple, eddies, hurricanes, convection currents, sunspots, planetary orbits, galaxies, DNA.
Associated Mathematical Terms: The Archimedes spiral maintains a constant distance between coils and increases arithmetically (see picture). The logarithmic spiral (also called equiangular or proportional spiral) increases geometrically, usually by the number $\phi = 1.61803\ldots$, where $\phi = \phi^2 - 1$. Phi (ϕ), or the proportion 1.61803:1, is called the Golden Mean or Golden Ratio. Phi (ϕ) is approximated by the ratio of each number in the Fibonacci series of integers to the previous number, where each number in the series is defined as the sum of the preceding two numbers, i.e., 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, etc. The ratio of F_{16}/F_{15} in this series is 1.618032786.
Examples in Garden and Permaculture Design: Spiral garden; Spiral plowing





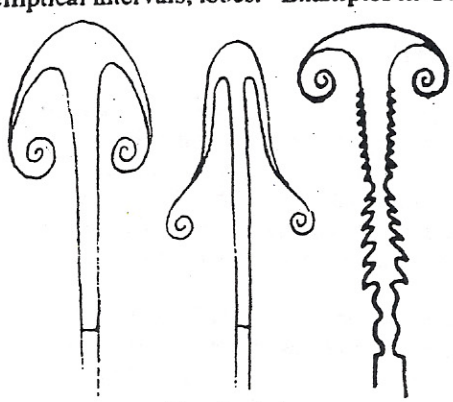
Phyllotaxis

Shape:
Fibonacci
angle or ideal angle
Purpose or Function:
Distributes leaves to provide maximum exposure to sunlight with minimum overlapping of leaves.
Examples in Nature: Phyllotaxis, which is the distribution or arrangement of leaves or buds on a stem, or seeds in a flowerhead.
Associated Mathematical Terms: Fibonacci angle = 137.5°; Divergency constant, approximately .3819 = 137.5/360, defined as (t/n), where t = the number of turns around a stem or axis, and n = the number of leaves; e.g. 1/2, 1/3, 2/5, 3/8, 5/13, 8/21. Notice the Fibonacci numbers recurring in the ratio Fn/Fn+2.
Examples in Garden and Permaculture Design: spiral garden



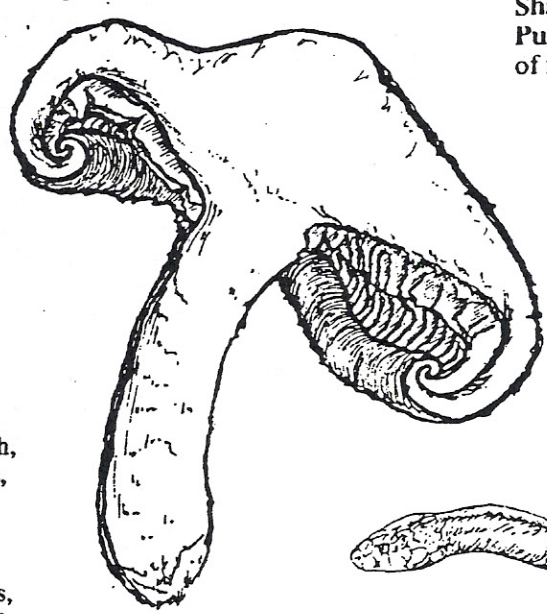
Patterns of Flow

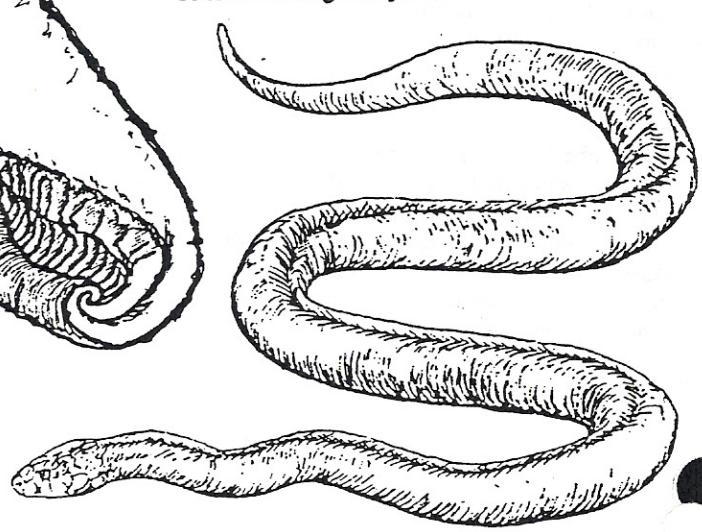
Shape: Meander, Waves, Ripples
Purpose or Function: movement, circulation, transportation, uniform expenditure of energy
Examples in Nature: streams, rivers, glaciers, sand dunes, moray eel, snake
Associated Terms: laminar flow, vortices, turbulence, elliptical intervals, lobes. **Examples in Garden and Permaculture Design:** edge effect, crenelated edge of pond, lobular pathways and gardens.



Overbeck Jet

Shape: Streamlines, Overbeck jet
Purpose or Function: Natural streamlining of fluids and gases past fixed bodies;





generates vortices or spirals.
Examples in Nature: mushrooms, jellyfish, rivers flowing into the sea, cream in coffee, van Karman trails in water, Ekman spirals in wind Associated Term: Torus
Examples in Garden and Pc Design: keyhole garden; mandala garden; flowforms, permanent forest edges, windrows, and hedgerows.