The Geometry of Botany

John Kokajko's Plantscapes

February 12 to Sugust 16th 2012

South Florida Museum

Marie Selby Botanical Gardens Series #6733
Philodendron bipinnatifidu

The Geometry of Botany

An exhibition of John Kokajko's Plantscapes

February 24, 2012 to April 8th, 2012

South Florida Museum

201 10th St. W, Bradenton FL 34205
www.southfloridamuseum.org

Curator Matthew Woodside

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Artist's Statement:

Photography has been an important tool for me since the 1960's. In 2011 I set myself the challenge of creating a series that would express my central artistic vision.

Using the native and imported plants found on the Florida Gulf Coast as my subject matter I have created images, somewhat idealized and abstract, that illustrate my respect for form and structure. Cues for actual size are missing or altered, a spiral coiled fern becomes visually equivalent to a Hubble view of the Whirlpool Galaxy. Mathematical forms are revealed as a natural consequence, illustrating both the simply geometry of linear equations and the controlled chaos of non linear fractals.

These are subtly manipulated digital images printed by myself on 100% cotton rag paper with a commercial grade ink jet printer. This combination yielded a depth of color and fine surface texture that fulfilled the images for me.

Curator's Statemen

Often taken for granted, the symmetry and patterns evidenced in nature are all around us. Rarely do we ask why these structures exhibit the shapes and patterns they do, and yet, we see them in breaking waves, apple tree blossoms, curves of shells and the patterns of emerging leaves and petals in all types of plants.

This exhibition of photographs by John Kokajko, serves as a point of departure for a conversation about nature's harmonies and structures that are the result of natural selection. Illustrating interesting borders between science, math, and art, the photographs also evoke a philosophical awareness that nature is amazingly complex and beautiful at the same time.

We ask that you look closely at the photos and question why these everyday examples of nature's design decisions are often times replicated in the things we make. Humans own a place on the planet and, as we continually learn, are integral parts of a greater whole. These photographs and the analysis of the geometry that can describe botanical structures can become the evidence supporting the idea that, on this planet everything is connected.

Marie Selby Botanical Gardens Series # 7663
Asplenium nidus, "bird's nest fern"

Marie Selby Botanical Gardens Series #6904
Philodendron bipinnatifidum

Marie Selby Botanical Gardens Series #6432
Angiopteris palmiformis "mule's foot fern"

Marie Selby Botanical Gardens Series #6312
Furcraea foetida "giant cabuya"

Marie Selby Botanical Gardens Series #6539
Alcantarea imperialis

Marie Selby Botanical Gardens Series #5839
Agava

Marie Selby Botanical Gardens Series # 6825
Anthurium schlectendalii

Marie Selby Botanical Gardens Series # 5723
Brassica oleracea "collard greens"

Marie Selby Botanical Gardens Series # 6940
jade

Gulf Coast Plantscapes Series # 6495
Orthophytum

Gulf Coast Plantscapes Series # 7171
Cactus

Marie Selby Botanical Gardens Series
7681 Aroid

Gulf Coast Plantscapes Series # 8103
Sabal palmetto "sabal palm"

Marie Selby Botanical Gardens Series
7292 Hechtia lindmanioides

Marie Selby Botanical Gardens Series
7302 Aloe thraskii

BOTANY AND GEOMETRIC PATTERNS IN NATURE

The ratio, 1 to 1.618..., underlies many of nature's works from the spiral form of galaxies to the shape of the smallest sea creatures, from a falcon's spiraling flight pattern to the curve of ram's horns, to the unfolding of leaves and the structure of flowers, seed pods and more.

This ratio, known as the Golden Ratio, is a unique number and its all around us, buried in the repeating patterns of our world. It has been a subtle influence finding its way woven into thousands of years of mankind's art, architecture and design.

In 1202, **Leonardo de Pisa**, nicknamed, **Fibonacci** (son of Bonacci), wrote a book of mathematical problems, one of which concerns the rate at which rabbits reproduce:

A certain man put a pair of rabbits in a place surrounded on all sides by a wall. How many pairs of rabbits can be produced from that pair in a year if it is supposed that every month each pair begets a new pair which from the second month on becomes productive?

Month by month, the numbers lead to a series, as follows: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89,144....this series is interesting because each number is the sum of the preceding two numbers. In recognition of his discovery this series is now known as the Fibonacci series.

Swiss mathematician, **Jakob Bernoulli** (1654-1705), famous for describing the principles that would later inform our understanding of carburetors, or airplane wings in flight, became so obsessed with the properties and perfection of the logarithmic spiral that, in 1670, he wrote a book on the subject: Spira Mirabilis - the wonderful spiral.

Theophrastus (372-287BC), **Pliny the Elder** (23-79), and **Leonardo da Vinci** (1452-1519) all noticed that leaves forming around a stem do so in a regular spiral pattern. Da Vinci even quantified it as 5 leaves every 2 turns. In botany, this is written as 2/5. Different trees have different ratios, for instance, Pussy Willow is 5/13, but they always turn out to be alternate terms in the Fibonacci series and are therefore closely related to the Golden Ratio. The Greek philosopher and mathematician, **Pythagoras** (570-495BC), of right-triangle fame, a2 + b2 = c2, discovered the Golden Ratio but the first person on record as actually calculating it is **Euclid** (ca. 300BC), the father of modern geometry. Its value is 1.618033988..., the dots meaning it is a never-ending, never-repeating decimal.

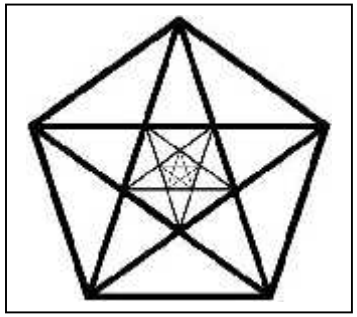
Dividing a circle, using reasoning similar to Euclid's, a Golden Angle can be calculated; its value is 137.50°.This number is also significant in botany.

In 1837, **Louis and Auguste Bravais** showed that when plants produce new leaves, they tend to advance around the stem of the plant in a tightly wound spiral pattern at an average angle of 137.5° to each other. At the time there was no explanation for this, but recent studies show that, for optimum exposure to sun and moisture, infinitely large leaf arrays indeed settle, on average, around this 137.5° pattern. Using the Golden Angle means that leaves never occur directly above each other on

the stem. Leaf arrangements are therefore related to the Golden Ratio in yet another way.

Flowers and seed heads of some plants, like the pinecone, coneflower or sunflower, can be considered very compressed stems that have large numbers of florets placed around them. If we look at a closed-up pinecone or the center of a sunflower, we see spiral patterns going both clockwise and counter-clockwise. You can trace the same thing on the surface of a pineapple and in certain cacti. The numbers of spirals exhibited in each direction are always consecutive terms of the Fibonacci series and therefore in the Golden Ratio. Studies show that this arrangement turns out to make the most efficient use of space on the seed head.

Johannes Kepler (1571-1630), the astronomer who developed the first mathematical description of the solar system, noted that the ratios between consecutive terms in the Fibonacci series, 2:3, 3:5, 5:8, 89:144, etc., converge to the Golden Ratio calculated by Euclid.

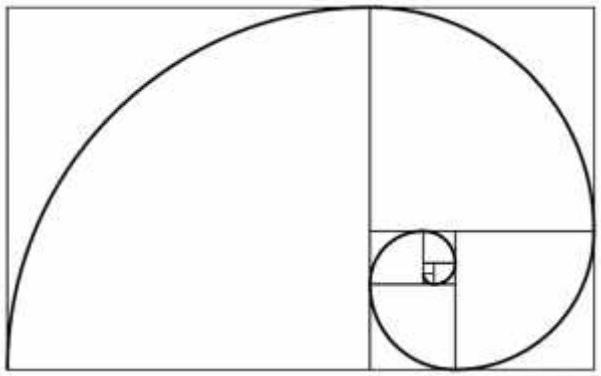


There are many forms in the natural world that reflect the five-fold symmetry of the pentagon. In any guide to plants, five-petaled flowers predominate. Join the points of the petals and you get a pentagon. There are starfish, sand dollars, okra and, of course, star fruit that exhibit this five pointed symmetry; even if you slice the humble apple across rather than vertically you will see a five-pointed star shape. Try it next time you have an apple. The individual seed segments are called carpels.

In a regular pentagon the relationship between a side and a diagonal is the Golden Ratio.

Pick up any guide to flowers or the blossoms of trees and you will find that the majority of blooms have five petals, some three and some, like daisies or asters, have higher numbers. Few have petal numbers that are not in the Fibonacci series; for instance, lilies have 3, buttercups 5, marigolds 13 and asters 21. Most field daisies have 13, 21 or 34 petals

In many plants, such as ferns, new growth emerges as a gracefully unfurling spiral. These forms can be described as a logarithmic or repeating spiral. A property of this is that no matter where a radius is drawn from its center, it always meets the spiral at the same angle. The spiral's architecture has direct dimensional relationships with the Golden Ratio, or as expressed in the Fibonacci ratios, 3/5, 5/8, 89/144... etc.



Golden Rectangle

Mule’s foot fern at Marie Selby Botanical Gardens

Another distinguishing feature of logarithmic spirals is that the smallest part of the spiral magnified and superimposed on the larger part, will fit it exactly. The mathematical name for this is self-similarity and it occurs in many natural features of all scales, like spiral galaxies, hurricanes, ferns and the veins of a leaf as it unfolds.
Logarithmic spirals are unique in yet another way; they fit neatly inside a Golden Rectangle, a rectangle whose sides are in the proportion of 1 to 1.6180555.... (Look at one of your credit cards!)

Golden Rectangles also possesses the property of self-similarity and have been used by artists, painters, and graphic designers for centuries because people tend to respond in a positive way to that set of proportions.

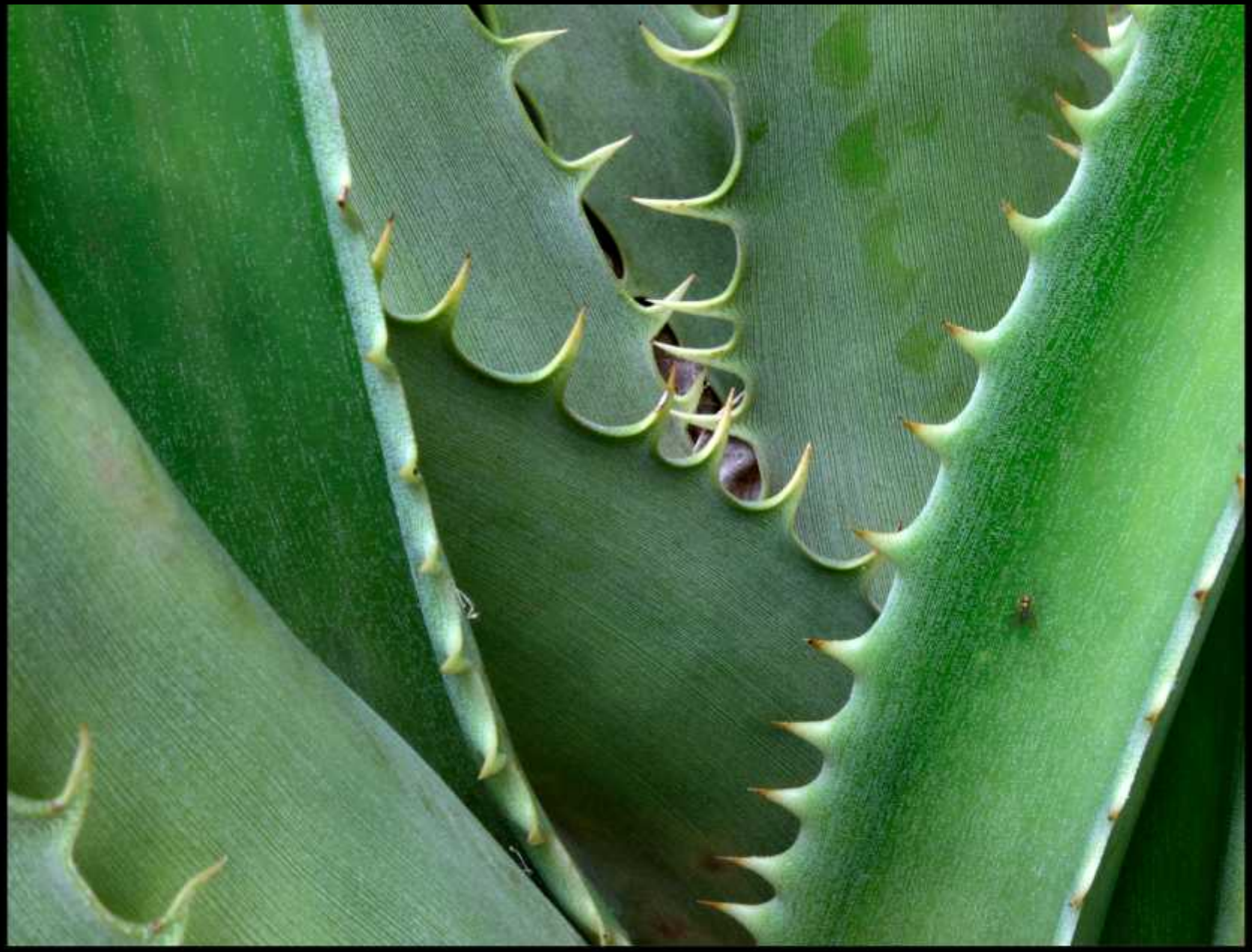
Nature is in love with logarithmic spirals. The spirals we see on the head of a sunflower, in tiny seashells, in hurricanes and even in the pattern formed when the water in your sink goes down the drain are all logarithmic spirals. So too, are the horns of rams, elephant tusks and some claws. Spiral galaxies are examples of logarithmic spirals on a cosmic scale.

Marie Selby Botanical Gardens Series # 5842
Agave geminirflora

Marie Selby Botanical Gardens Series #7281
Aloe aculeata

Marie Selby Botanical Gardens Series # 5908
Agave seemanniana

Gulf Coast Plantscapes Series # 6488
Agave regina



Gulf Coast Plantscapes Series #7128
Agava

Marie Selby Botanical Gardens Series # 6189
Chorisia speciosa "floss silk tree"

Marie Selby Botanical Gardens Series # 6144
Crinum augustum "queen emma"

Marie Selby Botanical Gardens Series # 5953
Hyophorbe lagenicaulis "bottle palm"

Marie Selby Botanical Gardens Series # 6324
Beaucarnea recurvata "ponytail palm"

Marie Selby Botanical Gardens Series # 6466
Kalanchoe thyrsiflora "paddle plant"

Marie Selby Botanical Gardens Series # 6553

Marie Selby Botanical Gardens Series # 6697
Dioon

Marie Selby Botanical Gardens Series # 6622
Cycas

Marie Selby Botanical Gardens Series # 6622
Cycas

Marie Selby Botanical Gardens Series # 6625
Cycas

Marie Selby Botanical Gardens Series # 6946
Hechtia lindmanioides

Marie Selby Botanical Gardens Series # 6660
Cecropia

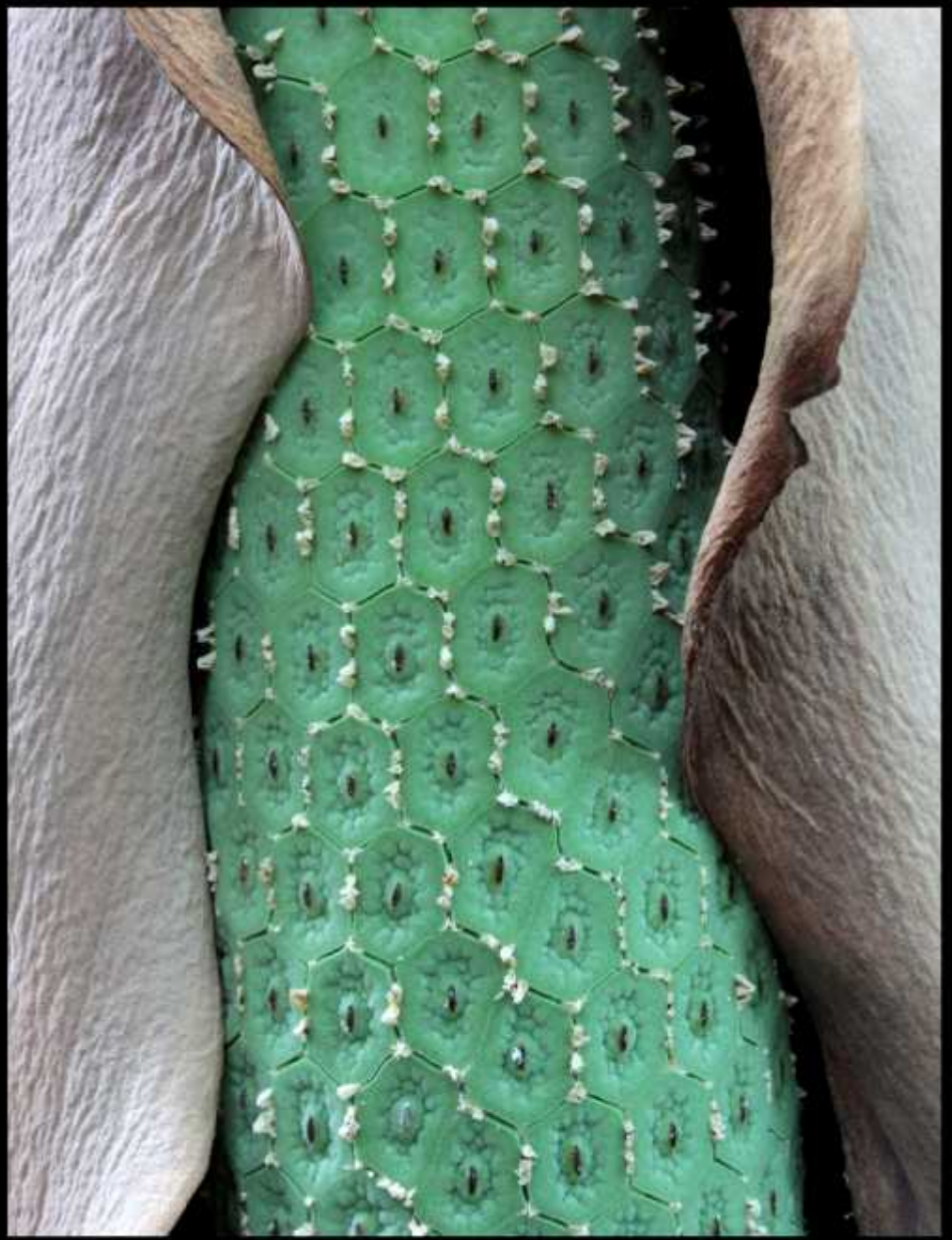
Marie Selby Botanical Gardens Series # 6975
Neoregelia johannis

Marie Selby Botanical Gardens Series # 6335
Bromelia balansae

Marie Selby Botanical Gardens Series # 7555
Bromelia balansae

Marie Selby Botanical Gardens Series # 7443
Musa Acuminata "super dwarf cavendish"

Gulf Coast Plantscapes Series # 8083
Sabal palmetto "sabal palm"



Marie Selby Botanical Gardens Series # 7868
Bambusa oldhamii "giant timber bamboo

Marie Selby Botanical Gardens Series # 7868
Bambusa oldhamii "giant timber bamboo

Technical details: This series was shot with a 15.5 MP Canon Rebel T1i using the standard lens sold with the camera (EF-S 18-55mm 1:3.5-5.6 IS). All of the exposures were taken at the smallest aperture available for the focal length used, which ranges from F36 at 55mm to F22 at 18mm. Typically the exposures were greater than one second; a tripod was always used. These are digital images; manipulations included adjusting for tonal range, color balance, dust/dirt/spot removal and sharpening. A few had saturation values decreased. These manipulations are meant to be invisible to the viewer, what is meant to be obvious is that the images are somewhat idealized and abstracted. Images were optimized for printing at 350 dpi on an Epson 3880 ink jet printer using 100% cotton fiber paper (Epson Hot Press Natural). The results yielded with this combination are distinctive. The depth of color and the fine texture of the surface (smooth but no gloss at all) work very well with these images. The printed image sizes are 16'x21' or 16x24' (MOL). They are available in limited editions of 25. Prints are always matted and framed because, although archival, the print surface is physically delicate.

About John Kokajko: Born and raised in suburban New Jersey John has also lived in Berkley, California and the backwoods of Maine. He presently lives in Bradenton, Florida,.Photography has been part of John's life from grade school in the early 60's. Ansel Adams and Edward Weston were major influences.

Occupations have included: laborer for a utility company, Data Control Clerk, maintenance/repair handyman, woodsman (theme song "He's a lumberjack and he's OK"), whitewater rafting guide, white water rafting outfitter/B&B proprietor, Physical Therapist Assistant, Real Estate Agent, Licensed Residential Contractor and Real Estate Broker. He has also done some commercial photography and marketing consulting along the way. John has documented and participated in a number of a

events in Bradenton's Village of the Arts and the annual Art Slam events hosted by Realize Bradenton.

John Kokajko at Marie Selby Botanical Gardens, photograph by Andre Pied.