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some thoughts on the

Aesthetics of Bromeliads

Lloyd Godman

Introduction

Responding to colour, and form, humans are *créatures visuelles*. It is no surprise then that the wildly diverse variations of leaf colour, shape and structural form in plants from the family Bromeliaceae (Bromeliads) for many admirers prove irresistibly intriguing and captivating. A little research reveals that this amazing family of plants are indeed credited with offering the widest range of variation of colour and shape within any plant family. This is not only witnessed this in the leaf, but also in the colours and shapes of the appendages associated with flowering.

Beyond the seductive visuals, an understanding of the fascinating biology Bromeliads have evolved, reveals complex systems far advanced from the first plants that emerged on land during the Ordovician period, around 450 million years ago. In fact, even the earliest examples within the family are very recent arrivals to the kingdom plantea appearing but 70-50 million years ago with many of the 3,000 species evolving just 15 million years ago; about the same time as primates began to populate the planet. It appears that in Bromeliads, nature developed a sophisticated means of photosynthetic growth and decided to announce it flamboyantly with the application of a comprehensive paint box of pigments and designs.

Aesthetically, the leaves of many species rival the wild splashes and random patterns of non-representational art like abstract expressionism, while others reference the hard edged lines of minimalist art and recent zany hybrids seem to apply colour as a post modernist statement with a dash of every style imaginable.

In 1996, as a photo-based artist I was drawn to these enigmatic plants as a subject, not to paint, draw, photograph or sculpt, but as a *subject real*. Exploring the action of photosynthesis, I cut alchemic symbols from opaque tape, placed them on the surface of wide leaf plants like Neoregelias and Nidulariums, exposed them to sunlight for months, removed the tape to reveal a rudimentary photosynthetic image grown within the tissue of the leaf. While the image was ephemeral, fading away over time, the fleeting images were archived through photographing the resulting effect.

My art practice with Bromeliads further developed, where, I engaged in a series of installations with epiphytic plants in coal burning boiler houses (*plant rooms* - playing with ideas of the epiphyte and the parasite) and other locations seemingly incongruous sites, including elevators. Quickly the work evolved into complex, interactive light installations of Bromeliads suspended from the ceiling of art galleries. Over 20 years of projects with Bromeliads, these plants have become a unifying signature within my work.

Cause and effect - Various Alchemic symbols - 1996 - grown into the tissue of Neoregelia carolinae

The human, the surrogate, the remains. -Tallandsia installation. Tableau Vivant 1999

In 2005 I sold my collection of plants in New Zealand and moved to Melbourne, Australia where I immediately began collecting again. Within a few years I began the slow task of cross pollinating and hybridizing Bromeliads as living art works. In 2007 I germinated the first seed, nurturing the tiny dots of green patiently. Eventually by 2014 the first of these plants had grown to mature flowering plants revealing the mystery of colour within their DNA.

The new plant creations are my on going statement as an ecological artist about environmental problems that concern me; humans interaction with the processes that drive the planet like CO_2 emissions and genetic diversity within other species that we share the earth with.

Scientists suggest we are facing the sixth mass extinction, the likes of which has not been seen on earth for at least 65 million years. This mass extinction of species is occurring through land clearing, mon-cropping and even collecting plants. Bromeliads are not immune from these effects with millions of plants destroyed every year through deforestation to plant mon-crops, and ironically native colonies of Bromeliads becoming endangered through over collecting to support the growing demand for rare plants. Or in the case of the Dyckia distachya, native to the rocky banks of the River Uruguay which is threatened with extinction because of the construction of a dam for the Itá Hydroelectric power plant. The World Conservation Union (IUCN has included 151 Bromeliad species (IUCN, www.iucnredlist.org, access 10/17/2006) at varying levels of conservation status in their international *Red List of Threatened Species.*

The unique genetic code of each new hybrid plant references the rapid loss of genetic diversity of species within the planet. As living art that expands genetic diversity, they also ironically act as symbols for the loss of other species. The work not only comments on these issues but is an action in what is termed *social sculpture*.

Genetic diversity refers to the total number of genetic characteristics in the genetic makeup of a species. It is distinguished from genetic variability which describes the tendency of genetic characteristics to vary. Genetic diversity serves as a way for populations to adapt to changing environments. With more variation, it is more likely that some individuals in a population will possess variations of alleles that are suited for the environment. Those individuals are more likely to survive to produce offspring bearing a vital allele. The population will continue for more generations because of the success of these individuals.

Wholesale Bromeliads of Australia

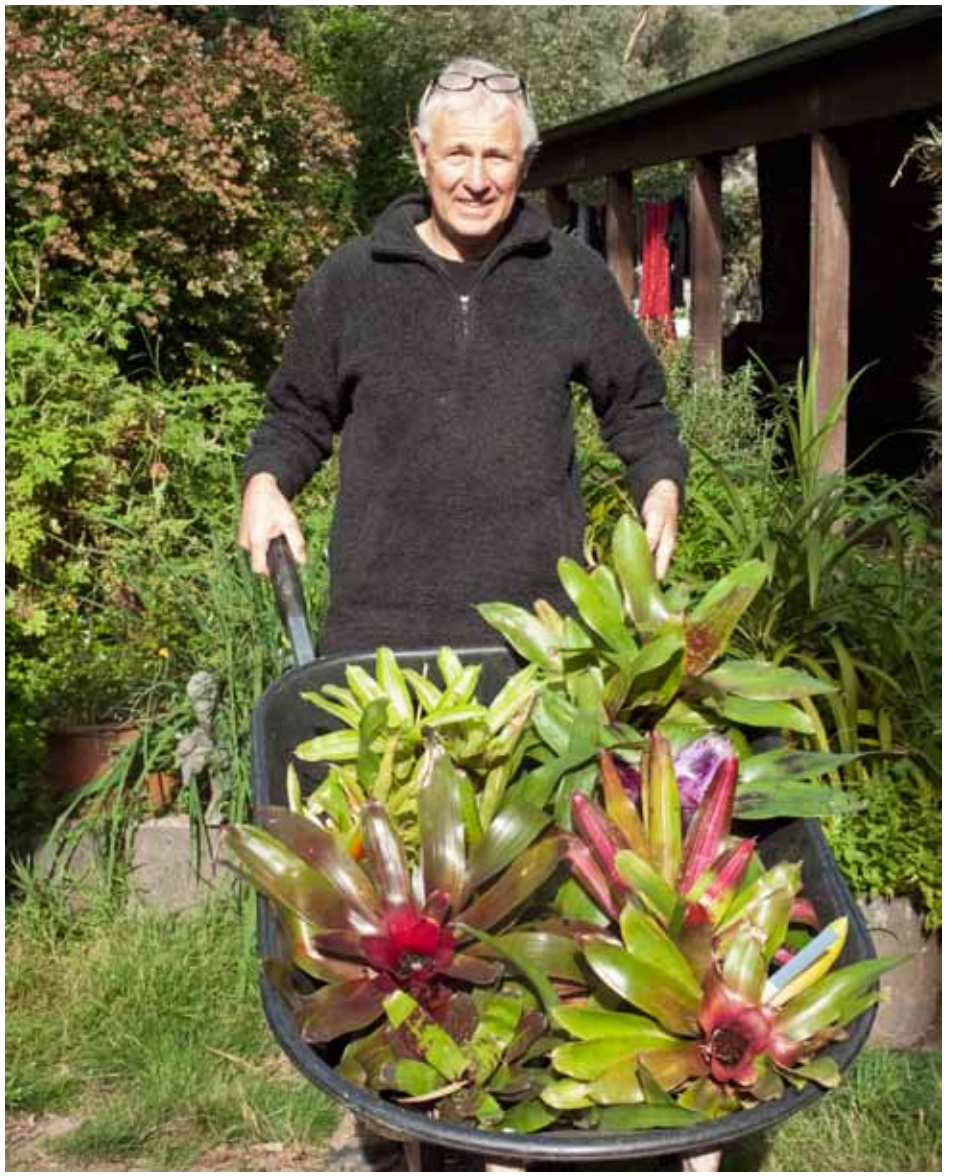
Flowers in the centre of a Neoregelia

These new hybrid plants I am creating are also a statement about the release of carbon into the atmosphere and the changing climate. For this project, I name the new hybrids after carbon emitting devices (cars) but Latinize the name: for instance, *Neoregelia oldsmobileii cutlassae supremea sedanus*. The naming is a satirical play, but there is a creative method in the madness that challenges growers who have these plants to consider the issues. It is a project in its self which continues to expand, but one I do not have space to explain further here. However in due course it will be documented.

Because we respond to the visual stimuli that is expressed by colour in many Bromeliads, it is easy to assume that there is great genetic diversity in a multitude of new hybrids. However David Benzing pointed out that this unique expression of colour is not a full reflection of a plants genetic diversity, secrets lie hidden, unseen to the eye. Genetic diversity includes other factors that effect the plants success like temperature humidity tolerance, gas exchange efficiency, nectar production etc.

However with a strong background in visual arts, I became intrigued with the variation of colour patterns and looked for a means to understand this. I found some descriptive information with examples in the book, *Growing Bromeliads* compiled by the Bromeliad Society of Australia, published by Kangaroo Press. Expanding these descriptions, I was invited to have the work published in the *Bromeliad Society Victoria Newsletter Vol 30 No 4 Aug/Sep 2013* and later by the *Gold Coast succulent and Bromeliad Society Sept - Oct 2013*. An inquisitive nature of deepening these descriptions even further has driven me to write this book, to take my knowledge of fine arts and apply it to the aesthetics of Bromeliads.

Over centuries, fine art has developed many ideas and systems to describe and understand aesthetics, colour and design, much of which I cannot enter into in this book. Understandably it is an inexhaustible subject with volumes written and no doubt volumes to come. It is a subject where any set of rules is challenged by the next generation, where debate always rages, where contradictions are common place, where much is based on opinion and the fads of a certain age; so it is impossible to offer a definitive text.



Lloyd Godman with a selection of Neoregelia

Rather, the following are some thoughts on the aesthetics of Bromeliads based on my experience and knowledge of growing the plants and different aesthetic systems. The intention is to offer ways of seeing and understanding the amazing nature of these visually captivating plants. In compiling this volume, often I have skipped, cherry picked, abbreviated and interpreted aesthetic theories in a manner that I feel is appropriate.

It is important to remember that the task is made even more difficult because any living organism is but a snap shot in time. Also,the living plants can be exposed to a huge range of variances that alter their visual nature. For instance the same plant grown in different light conditions will produce variations of patterns, intensity of colour and leaf shape. Bromeliad leaves can alter dramatically from the juvenile pup to the mature parent plant. Amazing patterns can form on every leaf or only on a section of one leaf. Climate and fertilizer can play a role. With plants like Bromeliads, once they have flowered the leaf colour fades and eventually dies.

While some description is necessary about pigmentation, light and photosynthesis the intention is not to overwhelm the reader with art speak and science, but to use these in a simple accessible manner to offer an insight into how we might better appreciate the fantastic Bromeliad plants we grow or see. If the ideas and information is useful, then appreciate and apply it, if it is not, then discard it.

As head of a photo-department at an art school for 20 years and a photo-based artist, not only do I offer an insight on light and some photographic techniques, but I have used my skills as a photographer to present a captivating set of images of the Bromeliads I have grown or found in others gardens to accompany the text.

From the earliest of times, plants have inspired artists; the patterns and colours of plants still weave magic on contemporary visual creators. We see representations of plants in ancient Egyptian, Greek, Roman, Myan, Indian, Chinese cultures where the essential sustaining links of the plants to the culture and society are acknowledged in art.

From Christopher Columbus' second voyage in 1493 the western world was introduced to Bromeliads when he brought the pineapple (*Annas comosuso)* back to Spain. The popularity of the plant quickly spread through Europe and beyond, with a drawing of a pineapple plant appearing in *The Universal History of India* published Spain, 1535.

A reproduction of the first drawing of a Florida Bromeliad, Tillandsia fasciculata, by Mark Catesby, was published in 1730 as Viscum caryophylloides augustifolium in "The Natural History of Carolina, Florida and the Bahamas". [From Plant Life, a publication of The American Plant Life Society, Volume 1, Numbers 2 & 3, July & October, 1945.]

When Linneaus published his *Species Plantarium* in 1753 he listed fourteen plants from the Bromeliad family.

Despite the age of seductive, sophisticated technological societies we live in today, plants still inspire artists. Like other plant growers, Bromeliad growers have a desire to photograph their plants.

I always felt the wonderful paintings with exotic foliage by Henri Rousseau lacked something - Bromeliads.

Bob Grant of Wholesale Bromeliads of Australia

Back in the 1980s, my love of Bromeliads began in the unlikely location of Dunedin in the very south of New Zealand. Since then I have had the pleasure to visit some wonderful gardens full of amazing plants, brilliant nurseries and in the process met some great people who are as passionate about growing the plants as I am. I am indebted to the help and generosity of these people.

Dunedin Botanical Gardens, Dunedin, New Zealand

Maurine Green - Whangarei, New Zealand
I would look longingly over the catalogue of plants Maurine offered

Maurice Kellett, Hurstbridge, Victoria, Australia
Martha Goodie, Chicago, USA
Chris Larson, Victoria, Australia
Bob Grant, The Pocket, Billinudgel, NSW, Australia
David Benzing, Oberlin College, Oberlin, USA

Bromeliad taxonomy

Taxonomy is the science of classifying plants and animals through evaluating shared features and classifying them into a hierarchical structure. As a species is identified, it is given an internationally recognized two part name; the first part of this name is called the **Genus** (which is always capitalized) and the second part the name the **Species** (which is all lower case). *Vriesea erythrodactylon* is an example.

Within a colony of a certain species there can be variety where a pup or vegetative off-shoot shows morphological differences from the rest of the plant. If the mutated cultivar is stable it can be registered. These are called sports and cultivars which may differ by foliage shape or color or flowers.

On the other hand, hybrids are plants which have been cross-pollinated, often deliberately by a grower, perhaps to afford attributes of both parent plants in the new seedling. The creator of these plants who has accurate details of the parent plants involved in the cross, can registrar the plant with the Bromeliad Society International, and name the plant. Bromeliads cross-pollinate easily and hence the huge number of hybrids with names like Vriesea 'Burgundy Bubbles' which is a cross between Vriesea heterostachys X fenestralis.

It is a little more complex than this, but in short, there are thousands of hybrid Bromeliads, and the number of unregistered plants beggars belief.

A search further back up *Vriesea erythrodactylon* lineage, finds it is in the subfamily Tillandsioideae, which is in the Bromeliaceae family or commonly known as Bromeliads. But the Family sits within a more complex classification - Series: Liliales, Class: Liliopsida, Phylum: Magnoliophyta, right up to the Kingdom where all plants sit, under Plantae.

The scientific name is usually derived from Latin or Greek (or a modern word that has been Latinized). Bromeliaceae are members of the Class Liliopsida (monocots). Monocots comprise one quarter of all flowering plants and include some of the largest and most well known groups of plants: orchids, palms, grasses. Traditionally the family Bromeliaceae has been divided into three subfamilies: Pitcairnioideae, Bromelioideae and Tillandsioideae.

Recently the accuracy of DNA sequencing has challenged scientists to reevaluate where some Bromeliad species sit and to the frustration of many growers, the classification of many plants have been shifted. The chart on the opposite page illustrates this.

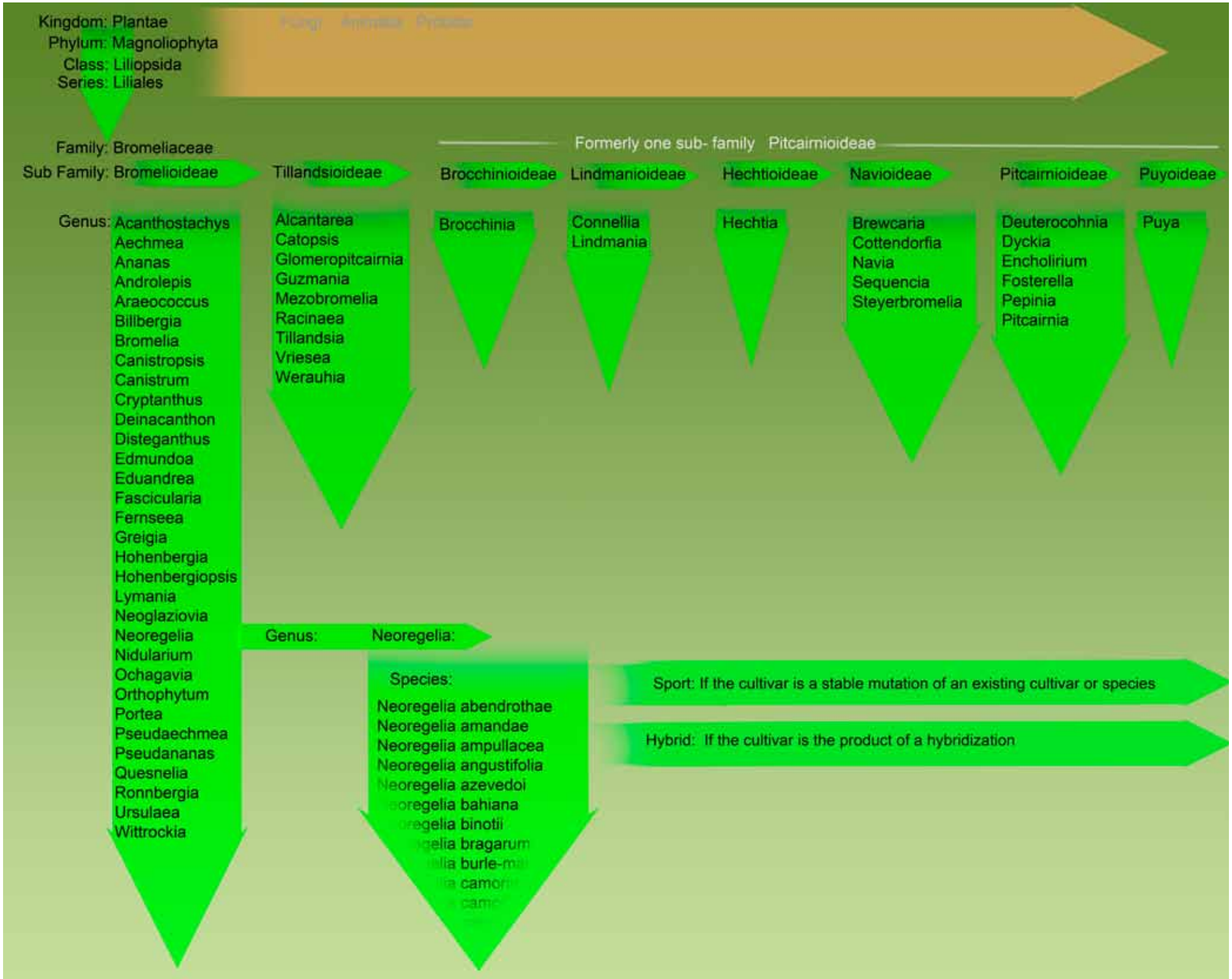
In looking critically at the aesthetics of a plant, and comparing it to others, understanding where the plants fit in terms of taxonomy offers an insight into leaf shape, colour, flower colour , seed berries etc.

Bromelioideae
This subfamily is the most diverse containing the greatest number of genera (but the least number of species). Most species in this subfamily are epiphytic and characterized by a rosette-like form many forming a water holding tank. They generally have spiny leaves and berry like fruits containing wet seeds which are often distributed by birds and animals who consume the fruits. Some genus, particularly Neorgelia, Aechmea and Billbergia can produce striking colour variation.

Tillandsioideae
This subfamily contains very few genera but includes the most number of species. Most of the members of this subfamily are epiphytes. All have spineless leaves and their fruit is a dry capsule containing winged seeds which are usually dispersal by breezes. The feathery plumes also help the seed to adhere to a suitable epiphytic surface for germination. This subfamily has special adaptations for survival in very dry (xeric) conditions. Some genus, particularly Vriesea can produce striking colour variation, while many Tillandsia have an overall silver appearance.

Pitcairnioideae
This group of subfamilies contains the most ancestral Bromeliads and many resemble the grass family from which they evolved. Almost all are terrestrial and rely on an extensive root system for their moisture and nutrients. They are generally spiny leaved and have dry capsules with small wingless seeds. Most plants produce a monchromatic leaf colour but an attractive feature of the plants can be their symmetrical form.

Recent studies have used DNA analysis to examine the relationship between the genera of Bromeliaceae. The results confirmed that the Tillandsioideae and Bromelioideae subfamilies are monophyletic (derived from a single ancestral form). Pitcairnioideae, however, was found to be paraphyletic and required five new groups to be split from it in order for Pitcairnioideae and the newly created subfamilies to all be monophyletic as well. This new reorganization of the genera within the most ancestral subfamily (Pitcairnioideae) hopefully now comes closer to representing their true evolutionary (phylogenetic) relationships.


Kingdom: Plantae
Phylum: Magnoliophyta
Class: Liliopsida
Series: Liliales
Family: Bromeliaceae
Formerly one sub- family Pitcairnioideae
Sub Family: Bromelioideae
Tillandsioideae
Brocchinioideae
Lindmanioideae
Hechtioideae
Navioideae
Pitcairnioideae
Puyoideae
Genus: Acanthostachys
Aechmea
Ananas
Androlepis
Araeococcus
Billbergia
Bromelia
Canistropsis
Canistrum
Cryptanthus
Deinacanthon
Disteganthus
Edmundoa
Eduandrea
Fascicularia
Fernseea
Greigia
Hohenbergia
Hohenbergiopsis
Lymania
Neoglaziovia
Neoregelia
Nidularium
Ochagavia
Orthophytum
Portea
Pseudaechmea
Pseudananas
Quesnelia
Ronnbergia
Ursulaea
Wittrockia
Alcantarea
Catopsis
Glomeropitcairnia
Guzmania
Mezobromelia
Racinaea
Tillandsia
Vriesea
Werauhia
Brocchinia
Connellia
Lindmania
Hechtia
Brewcaria
Cottendorfia
Navia
Sequencia
Steyerbromelia
Deuterocohnia
Dyckia
Encholirium
Fosterella
Pepinia
Pitcairnia
Puya
Genus: Neoregelia:
Species:
Neoregelia abendrothae
Neoregelia amandae
Neoregelia ampullacea
Neoregelia angustifolia
Neoregelia azevedoi
oregelia bahiana
regelia binotii
gelia bragarum
lia burle-m
a camo
cam
Sport: If the cultivar is a stable mutation of an existing cultivar or species
Hybrid: If the cultivar is the product of a hybridization

Bromeliad morphology

Plant morphology or phytomorphology is the study of the physical form and external structure of plants. This is usually considered distinct from plant anatomy,which is the study of a plants internal structure. When writing the aesthetics of Bromeliads I have attempted simplify the physical elements of the plants. However its is useful to visually identify these parts and the generic drawing is intended to offer clarity.

Roots

Over all, Bromeliads do not produce long tap roots but rather a series of fine wire like roots that spread outwards looking for nutrients, but more importantly as a means of securing the plant to a rock (saxicolous) or a tree (epiphytic). Root structures not only vary greatly across Bromeliad genera and species but are influenced by the conditions that plant is situated in. Grown in an open mulch like medium, rich in leaf matter, Neoregelia, Aechmea and Billbergia produce an intricate wide mat of fibrous roots. But when attached to the trunk of a tree that has clean bark the roots of the same species can be reduced to a series of shorter strong fibres that act to anchor the plant to the tree. Here the leaves dominant in nurturing the plant.

Vriesea and Alcantarea produce thick network of stiff wire like roots which in nature can attach very large plants to vertical rock faces. The ends of these roots spring from the base of the plant are rounded and blunt as though they have been cut off.

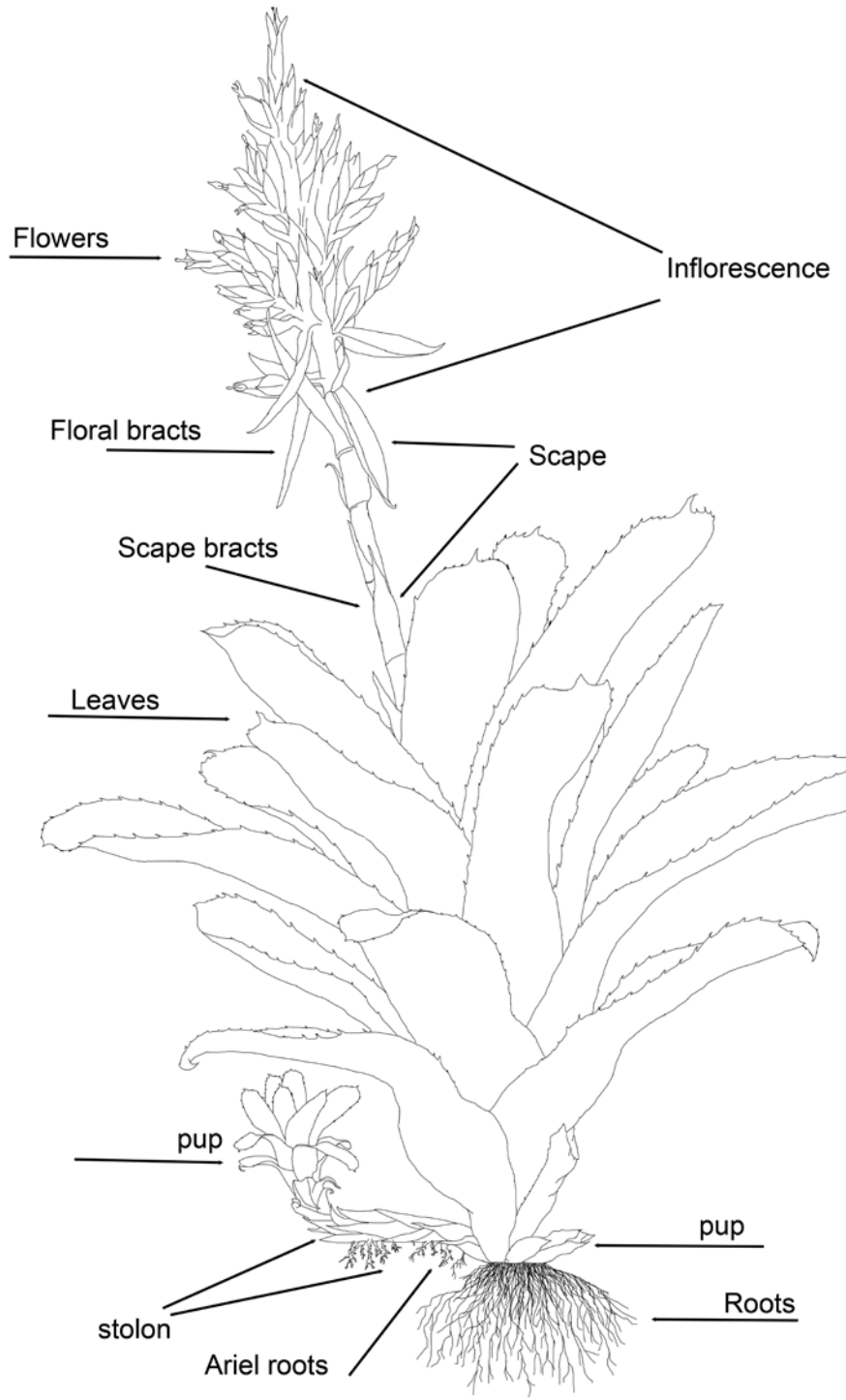
Many Tillandsia

Pups

As plants that grow asexually, Bromeliads reproduce from small plantlets that from the base of the mother plant called pups. These initially form as a pointed shoot that can be above the ground or below.

Stolon

Some Bromeliads form a long, often hard and fibrous stem that forms at the base of the mother plant which eventually evolves into a pup. Some species use this as a means of fixing themselves to a tree and also climbing higher.



Leaves

Scape

Scape Bracts

Inflorescence

Flowers

Flowers: Bromeliad flowers are never large and in some species are miniscule

Petal: Each of the segments of the corolla of a flower, which are modified leaves and are typically coloured.

Male elements

Stamen: The pollen bearing male organ of a flower

Filament: The filament is a fine stork on which the anther sits

Anther: The end of the stamen that contains the pollen bearing element of the flower.

Pollen: The fertilizing gains that cover the anther

Female elements

Pistil : the female organ of the flower which includes ovary, style and stigma

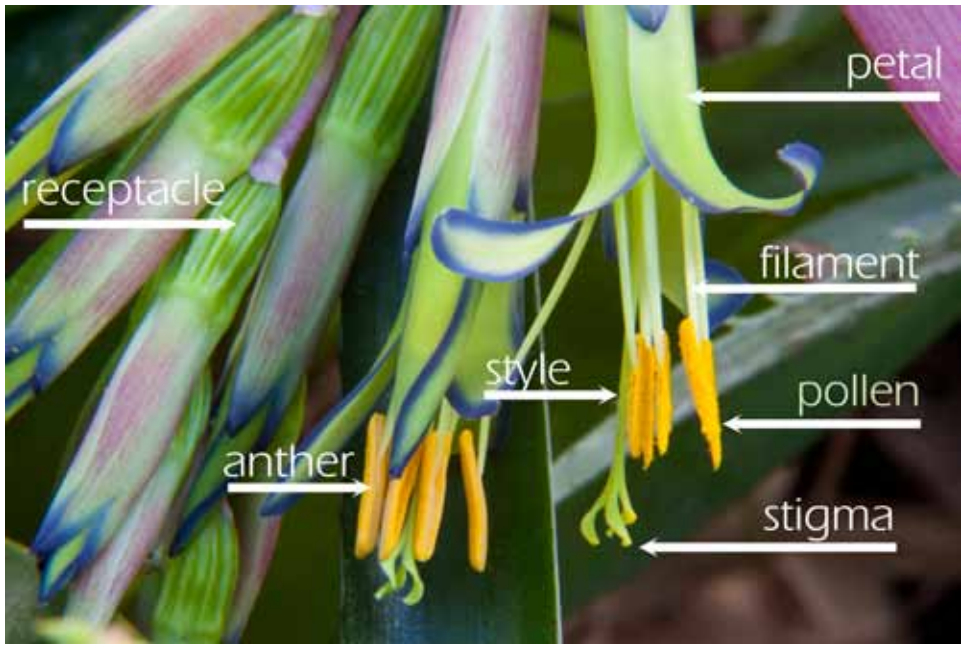
Stigma: The female element of the flower which receives pollen from the anther

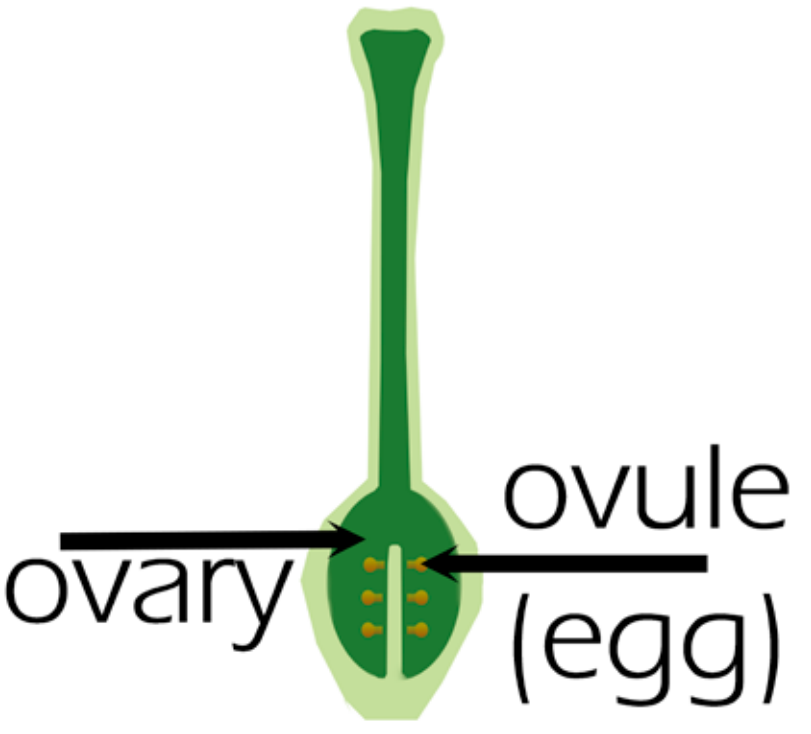
Style: The elongated element of the pistil between the receptacle and the stigma

Ovary / Ovule: these are invisible internal organs of the flower.

Receptacle: the receptacle or torus (an older term is thalamus, as in Thalamiflorae) is the thickened part of a stem from which the flower organs grow.

Seeds:





Bromeliad morphology

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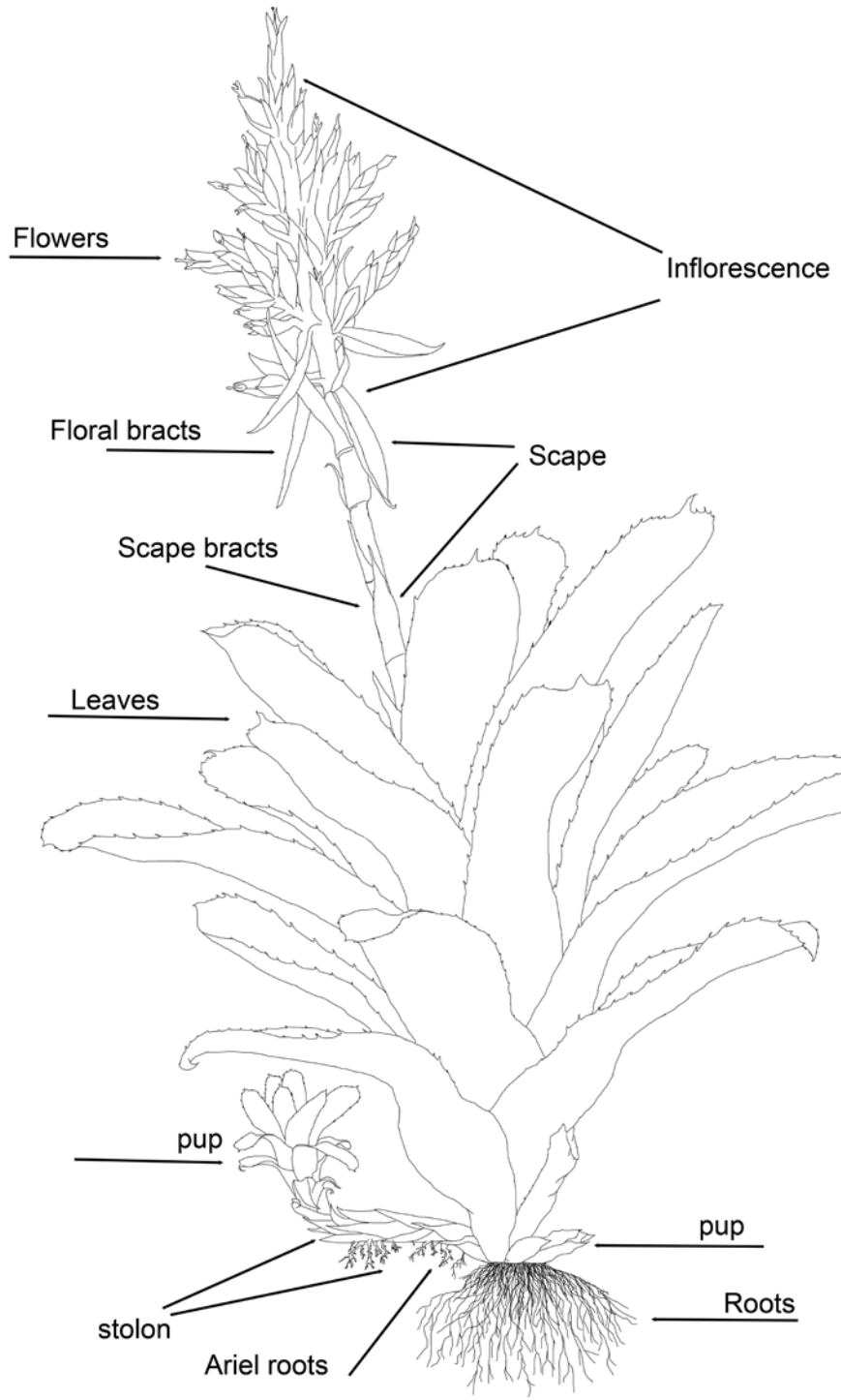
Across the range of Bromeliad species there is great variation within the various forms each exterior part of the plant part can take. For example, at flowering time, some plants like Billbergias produce a spectacular highly visible but short lived inflorescence which rises from a tube like form and arches over with pendant like flowers.

While in Neoregelias the flowers are set deep within a tight rosette where the central leaves turn vivid colours which can last for months. However, as there is no extended scape, these central leaves become the inflorescence and appear to morph from the external leaves. The ripening seed capsules form underwater in the centre of the vase and are hidden.

Many Aechmeas have an extended, erect scape with flowers that are short lived but produce highly visible, attractive berries that can take months to ripen.

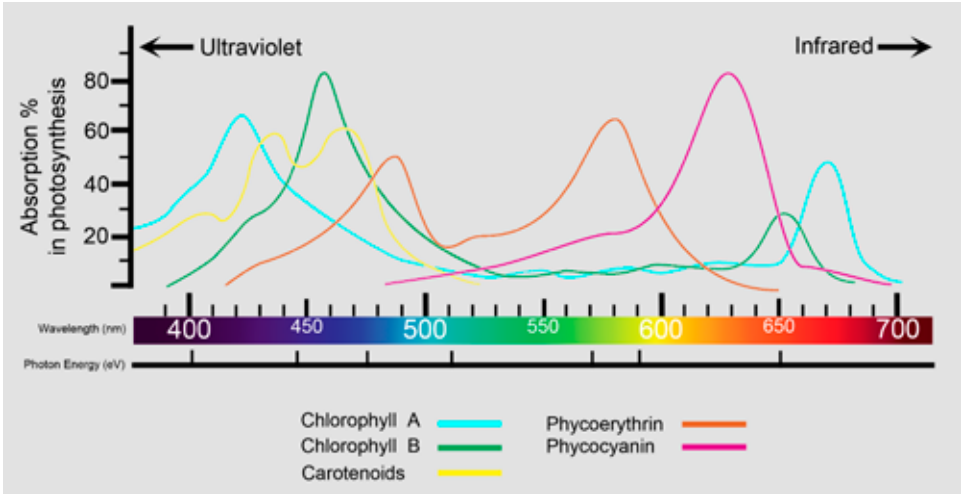


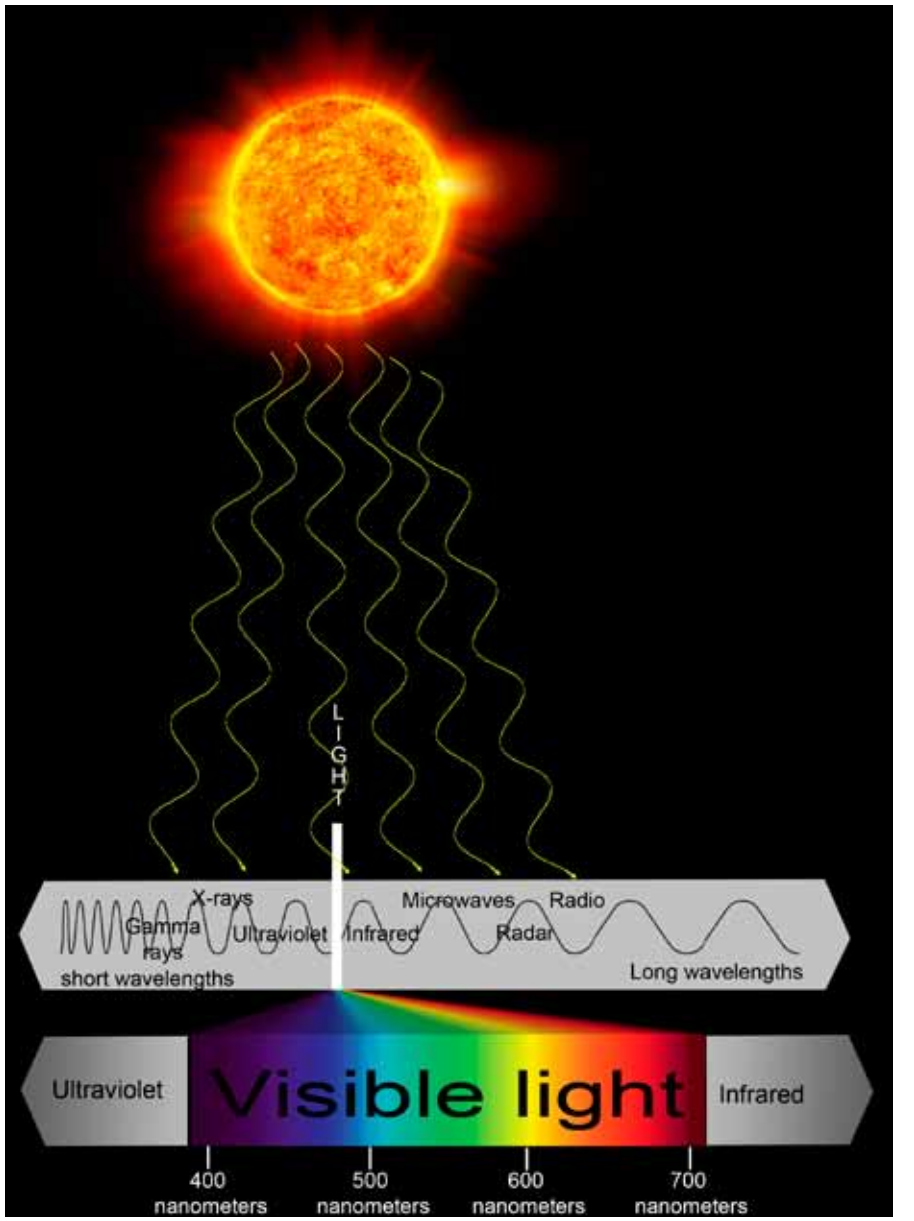
The Nature of Light

Light is at the core of what and how we see, but what is light?

A band of electromagnetic radiation from the sun in the form of light not only activates photosynthesis making plants like Bromeliads grow, but allows us to see the world including the colour and form of these plants. The spectrum of radiation that streams to the earth can be defined by the vibration or wavelength measured in nanometres, that means one nanometer is 1/1,000,000,000 m, so the waves are really minuscule vibrations.

Light is a narrow band of wavelengths that humans see within the extended electromagnetic spectrum, and outside this range of wavelengths are, Ultraviolet at one end and Infrared at the other which are invisible to us. Plants actually produce pigments that reflect Ultraviolet at different rates, and they might do so to attract pollinators. Some birds, bats and insects have extended vision and can see Ultraviolet, so when the plant is flowering, they can sense effects beyond our vision. However with special photographic techniques where concentrated UV light is directed onto the plant, film cameras that are adapted and special filters, it is possible to record UV represented in colours we can see in what is termed false colour. With digital cameras, the camera needs to be permanently adapted by removing filters in front of the sensor.

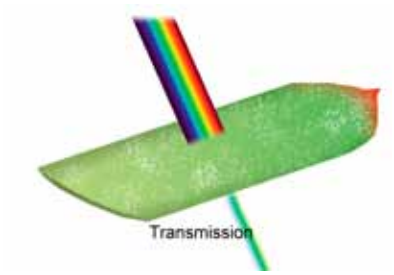


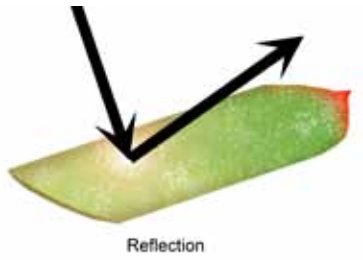


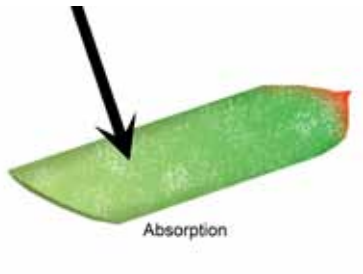
In this illustration we see that plants do not utilize all wavelengths of light equally to grow. It also shows that different pigments or colours in the leaf respond to different wave lengths of light. Photosynthesis captures the energy from visible light but it doesn't use all of the colours of light equally. It mostly uses light from the blue and red parts of the spectrum.

As radiation is broken down, again light can be broken down into its component colours with each one at a different wavelength. The shorter wavelengths at the violet end of the spectrum and the longer wavelengths at the red end. So looking at the nature of light allows us to understand how plants grow and also how we see the various colours in the leaves.

When light falls on any object like a Bromeliad leaf it is either reflected from the surface, absorbed into or transmitted though the tissue. The plant uses the energy of the absorbed light to photosynthesize and grow. Light not used is either transmitted through the leaf to a surface below while the reflected light is actually the colour we see and respond to.



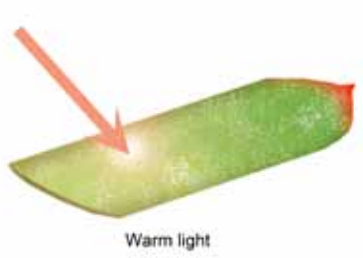


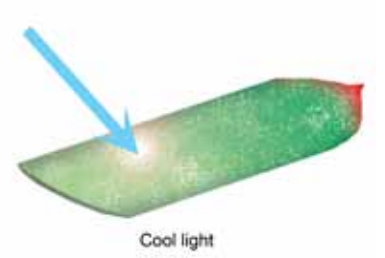


There are four aspects of light that affect all we see (including Bromeliads) and these factors also apply when we are taking photographs of our plants. There is not space in this book to offer detailed advice on photographing plants, but a brief description of these key aspects will not only allow us to see more in the colour patterns of Bromeliad plants but take better photographs of them.

1. The ambient colour of the light source

Not all light sources contain the correct mix of wavelengths to produce white light and therefor let us accurately see or photographically record the true colours of a plant. For instance daylight shifts from a warm hue (red) in the morning to cooler hue (blue) at mid-day. The flash on a camera, matched to a mid-day sun, is a much cooler or blue than most artificial light sources. Plants in shade will receive light of a cooler colour temperature than those in direct sunlight. This is what is termed colour temperature and can be adjusted via some camera menus as white balance. Although our brain adjusts for this, it is a critical factor in the colour we see and more importantly record with a camera.

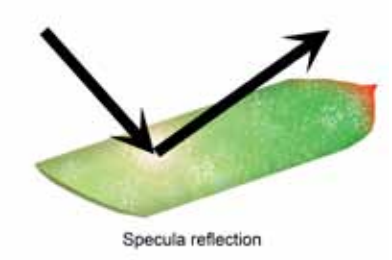


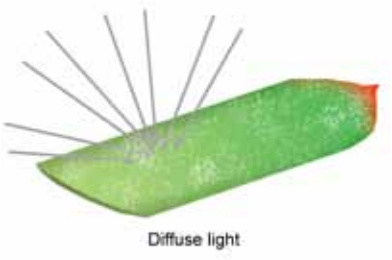


2. Quality of light

At one end of this spectrum is direct light where the light shines directly onto the subject, as in bright sun on a cloudless sky or a camera flash. Direct light creates a higher contrast range or light ratio from dark shadows to bright highlights. Because glossy and wet leaves reflect light like a mirror they are likely to produce specula reflections which might burn out an area of a leaf when we photograph it. On the other hand, matt leaves might be covered with a higher density of trichonmes which reduces the effect of specula reflection.

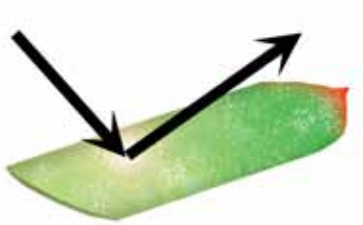
At the other end of the spectrum is diffuse light, where the light has a reduced contrast range or light ratio and is flat. Diffuse light is often direct light reflected from other surfaces like clouds during an over cast sky onto the subject. The shadows are filled with light while the highlights reduced. When using a flash to photograph Bromeliads, the light can be directed onto a reflector like an white or silver umbrella then bounced onto the plant to produce a softer quality of light.

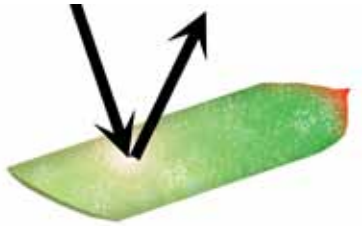

Specula reflection


Diffuse light

3. Angle and direction

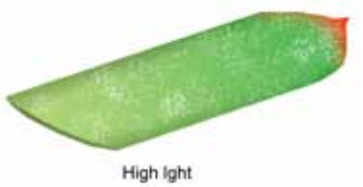
The angle the light source falling on a leaf in relationship to the position of the eye or camera alters what is seen. To alter the effect we can change one or more of these factors. For instance to remove a distracting specula reflection on a leaf, we can alter the angle of the eye or camera and or the angle of the leaf to the light source.

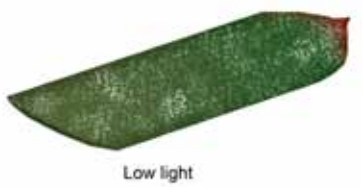

Low angle


High angle

4. Intensity of the light

This relates to the amount of light. In high light levels we see better and the colours on Bromeliad leaves have a greater vibrancy. Towards dusk, as light levels fall, we fail to distinguish as wider range of colours. This is because we have more rods in the eye than cones. The rods are more numerous, some 120 million but sense colour, where as the cones sense light but are less sensitive to colour. I dim conditions, brighter colours like yellows come forward and cooler colours like blue recede. However, when we take the time to photograph with a digital camera and tripod in low it can be surprising how much the camera can record that is beyond our optical range.


High light


Low light

Plant Pigmentation

The primary function of pigments in plants is photosynthesis, which uses the green pigment chlorophyll along with several red and yellow pigments that help the plant capture as much light energy as possible. Other functions of pigments in plants include attracting insects to flowers to encourage pollination. A pigment is any substance that absorbs various wavelengths of light with the color we see on a leaf is generated from the wavelengths of light reflected. So those wavelengths of light not absorbed by the tissue of the plant give it the distinguishing colour we are attracted to.

The green leaves of *Aechmea ramosa* are evidence of high concentrations of chlorophyll

Chlorophyll, the green pigment common to all photosynthetic cells, absorbs all wavelengths of visible light used by the plant to power chemical reactions except green, which it reflects and is detected by our eyes. So our perception of plants as green comes about not because plants have green foliage but because they reflect green light.

Theoretically, a pure black pigment would absorb all wavelengths. While some plant leaves might appear black to our eye, they are never pure black and able to absorb all light. In Bromeliads there are some plants with intriguing very dark, almost black leaves. However if we hold these leaves up to allow bright light fall on it, we can see some light passing through and a base colour is revealed.

As one might expect hybrids with dark leaves have been named accordingly - Aechmea 'Black on Black', Aechmea 'black satin' Aechmea 'black magic', Aechmea 'Black Flamingo', Neoregelia 'midnight', Neoregelia 'Prince of darkness', Neoregelia 'Tar baby'. Dyckia 'Keswick' x D. 'Arizona' and Cryptanthus 'zonatus' are other examples of dark leafed Bromeliads.

The dark almost black leaves of *Neoregelia midnight*

A pure white pigment the other hand would reflect all of the light energy striking it. However white is not a functioning pigment. While some plant leaves might appear white to our eye, they are never pure white reflecting all light, there is always some absorption. In Bromeliads we often see bold whites dramatically juxtaposed with other pigments in various forms of variegation. Hybrid Neoregelias like *Avodon, Blast , Carolinae tricolor, Ladds choice* are great examples. Other impressive plants with near white pigments are *Aechmea gamospala variegata* commonly known as "Lucky Stripes", *Aechmea distichantha "Var 'schlumbergeri' x'caudata melanocrate*, *Aechmea nudicaulis Mary Hyde*, *Billbergia Santa Barbara*, *Billbergia Oh Joy*, *Vriesea Megan*, *Vriesea Tiger Tim*.

While plants with white patterns can occasionally mutate and produce albino pups with no green and red pigments, it is the green, red, yellow pigments that utilize the light energy. As these mutant plants gain their energy from the parent plant, the off shoots never succeed through future generations because they cannot photosynthesize properly.

On a more complex level, plant pigments include a variety of different kinds of molecules, including porphyries, carotenoids, anthocyanins and betalains.

The principal pigments responsible for the colours we see are:

Chlorophyll is the primary pigment in plants; it is a chlorin that absorbs yellow and blue wavelengths of light while reflecting green. It is the presence and relative abundance of chlorophyll that gives plants their green color. Although there is chlorophyll a,b,c,d and e higher plant forms like Bromeliads possess two forms of this pigment: chlorophyll a and chlorophyll b.

You might well ask what is the difference between chlorophyll a and b?

Chlorophyll a
The principal photosynthetic pigment
Blue green in pure state
Exists in al phototrophs with bacteria being the exception
Formula is $C_{55}H_{77}O_5N_4Mg$
Molecular weight of 873

Chlorophyll b
Accessory photosynthetic pigment
Olive green in pure state
Exists in all phototrophs other than diatoms, cyanobacteria and algaes
Formula is $C_{55}H_{70}O_6N_4Mg$
Molecular weight of 907

The key aspect when looking at the aesthetics of Bromeliads is that Chlorophyll a and b produce slightly different colours within the leaf.

Carotenoids are red, orange, or yellow pigments that function as accessory pigments in plants, helping to fuel photosynthesis by gathering wavelengths of light not readily absorbed by chlorophyll. The most familiar carotenoids are carotene (an orange pigment found in carrots), lutein (a yellow pigment found in fruits and vegetables), and lycopene (the red pigment responsible for the color of tomatoes).

Anthocyanins (literally "flower blue") are water-soluble flavonoid pigments that appear red to blue, according to their pH level. They occur in all tissues of higher plants, providing color in leaves, plant stem, roots, flowers, and fruits, though not always in sufficient quantities to be noticeable. Anthocyanins are most visible in the petals of flowers, where they may make up as much as 30% of the dry weight of the tissue. They are also responsible for the purple color seen on the underside of many tropical plants, where the anthocyanin catches light that has passed through the leaf and reflects it back towards regions bearing chlorophyll, in order to maximize the use of available light. This happens in some Bromeliads where the pigment is a darker redder colour on the underside of the leaf.

In Bromeliads it is easy to distinguish yellow Carotenoid pigments but as Anthocyanins also produce red pigments it becomes more difficult to do this on a visual level.

In Bromeliads we see Anthocyanins as the darker red, purple blue in some leaves. They also appear in the juice of some Aechmea berries .

Chlorophyll normally masks the yellow pigments known as xanthophylls and the orange pigments called carotenoids — both become visible when there is less green chlorophyll. These colours can be present in the leaf at higher levels, but because of the active nature of the green pigment chlorophyll, it covers the yellow and the orange pigment.

The red anthocyanins apparently prevent damage to leaves from intense light energy by absorbing ultraviolet light and damaging the green chlorophyll cells. This is why Bromeliads placed on bright light often produce more vivid red colouration than in shady situations.

During a plants life, chlorophyll is continually being replaced in the leaves. Ironically as it may seem, chlorophyll breaks down with exposure to light in the same way that paper fibres, or the inks in a printed page fade in sunlight. Consequently, the leaves must manufacture new chlorophyll to replace chlorophyll that is lost in this way. Like all plants Bromeliad leaves have a limited life. It is quite natural for the often smaller leaves at the base of the plant to die and turn brown, but before they shut down, energy is transferred to the newer and larger leaves. In the wild these dead brown leaves remain and can give the plant an unsightly appearance, while most plants in a nursery have these removed before presentation for sale.

Over time, a series of new leaves combine to form a mature plant, and at this point a great deal of energy from the leaves is transferred in producing flowers. Once the plant has flowered the all the leaves of the parent plant die and the energy is either transferred to produce viable seed or into new pup production. This final energy transference process might take 18 months or more.

Once the energy is transferred, the trichomes fail, moisture is shut off to the leaf and all the pigments; green, yellow, orange red fade because of this lack of moisture. Then, the leaf becomes brown in colour dry and crunchy. This is the reason dried leaves pressed between heavy weights lose their colour.

(A hybrid swarm is a population of plants that appear to be natural hybrids. They are in transition to becoming a species.)

Alcantarea unicolor

Bromeliad foliage

As mentioned in the introduction, while some plant families may have a great genetic diversity between individual plants, species and genera, this may not be expressed in an obvious visual manner that is easily identified by the eye. However in this regard Bromeliads are exhibitionist, where genetic diversity is expressed in a highly visible manner, through leaf colour and shape. As one of the last plant families to evolve the genetic sequence can lead to a huge diversity of plants in nature and an even greater diversity when exploited by growers and hybridizers. Combined variations of pigmentation and trichmes in the foliage, which usually grows in a rosette, affords the most widely patterned and coloured of any plant family on the planet. So much so, that many people who first see these exotic plants with thick strap like leaves believe them to be "fantasy" plants designed in the imagination and made of plastic. I always felt the wonderful paintings with exotic foliage by Henri Rousseau lacked something - Bromeliads.

But these aesthetic factors are precisely what excites many people to study, collect and hybridize these plants amazing plants.

The foliage of plants, within the more than 3,000 species of Bromeliad family, (and the countless hybrids and cultivars) can take very different shapes, from narrow needle like leaf forms, leaves that taper from a wide base to a sharp point, to wide leaves with an almost square blunt tip. The leaves can be thin and delicate to thick and leather like. Through the cross section of leaf, they can be flat, or strongly curved, they can form symmetrically or irregularly, be very short to long and the leaf edge can vary from sharp spines to a smooth soft edge. The spines can not only vary in shape and spacing but also in colour which can often contrast dramatically with the leaf colour affording a visual accent.

These plants expression of anthocyanin pigments can be exquisite with a huge range of red, blue, or violet pigments possible. Likewise the range of greens in the chlorophyll pigments is also varied from light green to deep almost black green. Leaf colours range from almost black, maroon, bright red, pink through shades of green, to gold. But a more spectacular feature of many plants is the exotic combinations of pigments, where leaves have striking patterns. Varieties may have leaves with red, yellow, white and cream variations. Others may be spotted with purple, red, or cream, while others have different colours on the tops (adaxial) to the bottom (abaxial) of the leaf, stripes that run down the leaf length or across the leaf.

As mentioned, these colours are formed by pigmentations in the leaf, but as another dimension to the aesthetic of the Bromeliad leaf, tichomes can be invisible, or show as a thick white dusting, distinct silver bands, patterns or as in some Tillandsia even cover the entire plant in a silver fuzz. In some plants, trichome patterns can differ considerably from the upper side of the leaf to the bottom side. The trichome is not a pigment in the plant tissue, but a small cell on the surface that has the ability to uptake water and also reflect light.

Different genera within the family can look quite different. In some plants, exposure to high light levels can enhance the saturation of these pigments, while in other plants high light levels can bleach the colour and even burn the leaf. Further to this leaf shape can alter with differing exposure to sunlight, in bright light the leaves can be shorter and wider, while in darker situations the leaves can be longer and more strap like.

Leaf pigmentation patterns can take many forms: On some plants these pigmentation patterns form through the entire thickness of the leaf and reveal a similar pattern top and bottom, while in other plants the top of the leaf can be completely different from the bottom. It should be remembered that any terms are simplified definitions and often plants combine a range of these colour expressions within a single plant or even a single leaf, particularly in new hybrids.

Understanding color &design

Aesthetics is the study of interrelated marks, colours and shapes within an image. While these theories can be applied by an artist or designer to create images based on how people predictably read these abstractions, they can also be used to critique the effectiveness of an image. In the case of Bromeliads aesthetic theories are useful to look critically at a range of visual aspects pertaining to the plants.

Contrast in design
A fundamental overhaul of design theory took place during the 1920s in Germany at the Bauhaus in Germany. Because of its questioning and experimental approach to the principles of design, this school of art, design and architecture has had a major influence in contemporary design. Johannes Itten ran the basic course at the Bauhaus which has since became famous as the foundation for modern mass media design. Itten's theory of composition was rooted in one simple concept: contrasts; and this concept is an effective means of looking with a critical eye at the visual nature of Bromeliad plants.

Itten challenged students to explore contrast between light and dark (chiaroscuro), between shapes, colours, forms and even sensations.

While the first exercises he set for the students was to explore contrast which included large/small, long/short, dark/light, smooth/rough, transparent/opaque and so on was for image making, questioning via contrast also relates to looking at Bromeliads very well. His intention was "to awaken a vital feeling in the student for the subject through personal observation".

Itten directed his students to approach these contrasts from three directions, they had to - "experience them with their senses, objectify them intellectually and realize them synthetically".

- first they had to get a feeling for each contrast using all their sense
- then list various ways of putting the sensation across
- finally create an image that communicated this.

We are exposed to this method and principle every day in many successful images, painting, prints, photographs, advertising, graphic design. How often do we see an advertisement with contrasting large and small elements?

So when we look at contrast - it is easy to approach it on a visual sense - light dark, black white red green, large small, long short smooth textured etc. but we can also reference other senses. What we see, might evoke other senses.

• smell - pleasant foul, etc. In this case we might do this through memory, jasmine flowers next to a rotting corpse of an animal

• taste - sweet sour etc. In this case we might do this through memory, a jar of honey next to a lemon

• sound - loud, soft etc. This is harder to convey, but perhaps an image of someone with earmuffs on at a rock concert creates a contrast

• touch - smooth rough etc. In this case we can make a reference to texture through the use of light - the texture of a rough rock can be brought out against a contrasting polished surface. The sharp spines on a Bromeliad leaf edge against the smooth surface of the blade. This can be eventuated even further with a spine shadow falling on the smooth surface of an adjacent leaf.

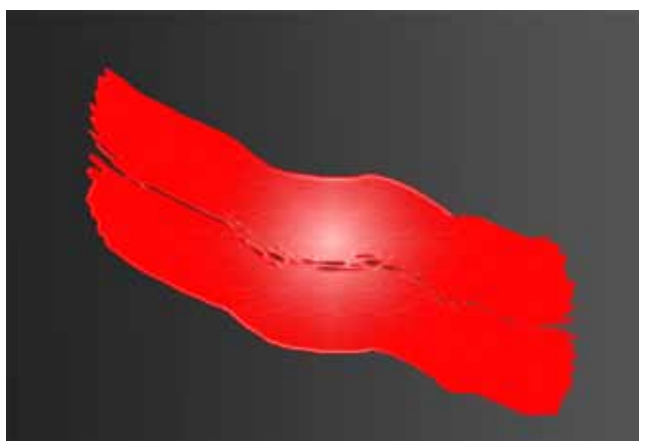
When we look at plants like Bromeliads we can begin to understand how we might be attracted to them by contrast, particularly contrast of colour.

Figure ground relationships

A term often used in fine arts and aesthetics is *figure* and *ground*. What is meant by figure is the visual element that becomes the subject. In a photograph or painting this might be a person a car, a vase of flowers. The term ground refers to the background that the figure sits against. In the simplest form this is a single figure or an object against a plain background. If the background is darker and the figure lighter, the figure comes forward creating an image with visual impact and draws our attention to it.

In abstract painting the figure might be an area of brightly coloured paint against a larger darker area and we can apply the a similar principle to the marks on the leaves of Bromeliads where an area of bright red pigment like an inflorescence projects forward from a more subdued green.

In realistic representation, we often see strong figure ground relationships with a person against a darker, plain, untextured background.



In an abstract form, the red mark becomes the figure against the darker background.

Over days, it can be fascinating to watch the bright inflorescence gradually emerge on many Aechmea and Billbergia. In the image above the red flower becomes a figure against the green silver tissue of this *Aechmea nudicaulis aequalis*.

The wide marron stripe on the leaf of *Neoregelia painted delight a*ttracts our attention as an abstract figure against the green pigment.

Patterns in plants and art - *Art takes nature as its model*. (Aristotle)

Early Greek philosophers like Plato, Pythagoras and Empedocles attempted to explain order in nature by studying patterns. Over thousands of years, the modern understanding of visible patterns in nature and how these can be adapted or referenced in art have continually developed. Age after age, artists are constantly inspired by the endless models of nature. Today's digital age, when the flow of photographic images of natural patters stream the internet ubiquitously, proves no different, the fascination is still compelling.

In his 1202 book *Liber Abaci,* Leonardo Bonacci introduced the Fibonacci series sequence to Western European mathematics as an attempt to explain natural pattern. The sequence of numbers materializes in the Fibonacci spiral: an approximation of the golden spiral created by drawing circular arcs connecting the opposite corners of squares in Fibonacci tiling and linked to the elegant curve of the nautilus shell. In Bromeliads, Fibonacci tiling is graphically evident in the leaf arrangements of some Dyckias, Hechtias, Pitcairnias, and the flower arrangement of Neoregelias, Aechmeas.

Albrecht Dürer (1471-1528) was fascinated by nature as he believed that the study of the natural world could reveal the fundamental truths he was seeking to discover through his art. He was one of the first artists to use nature as a subject in its own right. "*Nature holds the beautiful, for the artist who has the insight to extract it. Thus, beauty lies even in humble, perhaps ugly things, and the ideal, which bypasses or improves on nature, may not be truly beautiful in the end.*" Dürer's pen drawing of an Indian rhinoceros is a typical example of his interest in animals, which was based on some notes and a sketch done by an unknown artist done in Lisbon in 1515. While Dürer never saw a live rhinoceros, which accounts for its strange anatomical errors and the drawing shows the entire animal, sections of the animal's skin show wonderful patterns.

Ernst Haeckel was a German biologist, naturalist, philosopher, physician, professor, and artist who discovered, described and named thousands of new species. His drawings from *Kunstformen der Natur* (Artforms of nature) (1904) demonstrated a fascination with natural patterns.

Rembrandt 1606 – 1669 once said "*Choose only one master – Nature*".

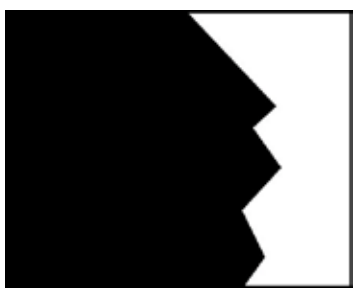
A more recent period, sees environmental sculptors like Andy Goldsworthy, creating stunning works in the landscape based on natural patterns. Ephemeral works created entirely from natural materials like, leaves, stones, berries, ice, wool. "*Carefully broken pebbles, scratched white with another stone, St. Abbs, Scotland, 1 June 1985*", is a great example of how Goldsworth arranges nature into patters and brings attention to them.

The abstract intricate patterns in works like *Indistinti confini (Frontiers indistinct)* 2012 by Italian artist Giuseppe Penone , seem to mimic the randomness of pine needles falling on white snow.

With close inspection, it seems even the most esoteric contemporary visual art can not escape a reference to the natural world. *Céleste Boursier-Mougenot, Clinamen,* 2012. Installation view from "T*okyo Art Meeting III: Art and Music – Search for New Synesthesia*," Museum of Contemporary Art Tokyo, Japan, demonstrates this point.

The unifying factor in all these artistic approaches that spans centuries, cultures and ideologies, is that visual patterns are created by contrast between elements and a figure ground relationship plays an important role in this.

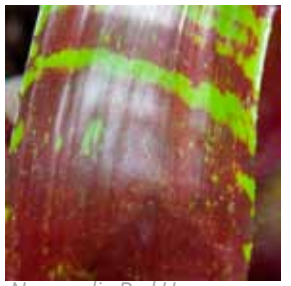
This illustration shows strong and dramatic contrast of black and white. Like letters on a white page, it demonstrates how visual elements are graphically separated through absolute tonal difference. While we do not see Bromeliads with black & white foliage, the image presents the power of bold contrasting tones that Itten identified.



Nidularium innocenti 'Ruby Lee' Variegated

High colour contrast: Contrast in colour works in the same way - the greater the contrast the more the zig-zag line between the two visual elements is defined. As in graphic design, Bromeliad leaves with saturated red and green affords the most dramatic contrast. Perhaps the strongest examples are in glossy hybrid Neoregeila leaves where the powerful bands of red and green play off each other. From this it is easy to understand why plants with dramatic colour contrast in their leaves are often so attractive to Bromeliad collectors.

Neoregelia Bobby Dasler



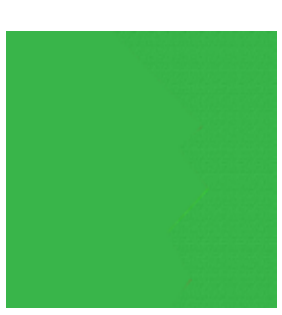
Neoregelia Red Heaven

Low colour contrast: When the contrast is more subtle the effect is not as graphic and the line between the two contrasting colours is less defined. The human mind has to work harder to distinguish a difference. In some Bromeliad leaves the colours can appear to merge, this can be partly the combination of pigments and also the translucency of light coming through the leaf where the colour pattern is different than on the upper surface. Like art, while the visual effect is less obvious, plants with these leaf patterns are alluring in a more subtle manner but require a more discerning eye to appreciate them.

Neoregelia Mr Irresistible

Neoregelia Red Mcaw

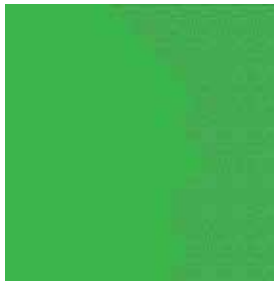
Low texture contrast: Contrast in texture can also act as a means of defining one visual element from another and can excite a tactile sense. In sculpture this might be a rough hewn section of stone against a highly polished element. We see this in Susumu Koshimizu's "*Stone soar*", Sapporo Art Park, Japan. In Bromeliads, the trichome cell coating that many leaves gives a sense of this. The effect is less dramatic in soft diffused light and accentuated in direct light that strikes obliquely across a surface.



Billbergia Vatatta

Neoregelia Prince of Darkness

High texture contrast: As the trichome cells sit above the main leaf surface, when direct light strikes these at an oblique angle each cell creates a series of surfaces where the light falls and behind the surface a shadow is cast so the visual effect in the way we read texture contrast is extenuated. The greater the contrast in texture, the more graphically the two are defined.



Billbergia horrida Var tierina

Trichome detail - Tillandsia recuvifolia V recuvifolia

Abstraction

The human mind is inquiring and desires to make sense of what it sees.

In a photograph or painting, what is really an abstraction of marks on a two dimensional plane can combine to represent something we know and understand in the real world. The *Treachery of Images* (French: *La trahison des images)*, 1928–29, is a painting by the Belgian surrealist painter René Magritte. The picture shows a pipe and below the pipe, are painted the words, "*Ceci n'est pas une pipe*." French for "*This is not a pipe*." Magritte's statement is taken to mean that the painting itself is not a pipe. The painting is merely an image or an abstraction, a series of marks that we might chose to read as a pipe.

Pure abstractions in art present a different scenario where in substitution of recognizable objects we try to make sense in patterns from nonrepresentational marks we might see on a canvas through other senses. The paintings of abstract expressionist painter Jackson Pollack are examples of this. "*The painting has a life of its own. I try to let it come through*", here, Pollock reveals the life of the painting through his "actions," an energetic technique of dripping and pouring paint on a canvas that is placed directly on the floor. In the approach, Pollock abandons the canons of traditional composition. As the paintings lack a central motif , the works also have any points of emphasis or identifiable parts. The non-figurative marks and patterns relate more as an expression of human emotions. A case in point is his painting *White Light*, 1954.

Another departure from representational art is Mark Rothko's technique of abstract painting which differs from Pollock's actions. Rothko's style was termed color field painting. His works consist of strong formal elements, where he used areas of almost uniform color, and applied them as large shapes, often simple rectangles against a contrasting ground, experimenting with balance, depth, composition, and scale. They confirm the ideas of the formalist critic Clement Greenberg, who suggested in "*Modernist Painting*" (1960) that artists should respect the limitations of each media. Because a canvas is a two-dimensional surface, painting should avoid any illusion of three-dimensional representation. Green Red Blue is a good example

Bridget Riley was among a group of artists who developed a series of works where high contrast, repetitive geometric marks combined to create highly optical patterns in what became known as Op-Art. When viewing these works, the high contrast patterns set of an optical reaction that exploited the fallibility of the human eye, giving the impression of movement, or a burst of light and visual vibration. Op Art captured the imagination of the public and became part of the swinging sixties. The fashion, design and advertising industries adopted the graphic, sign-like patterns and decorative values. Op-Art was seen as super fashionable, and during this period Bridget Riley became one of Great Britain's top art celebrities. Riley's patterns pulsed with energy, as in *Fragment 3/11*, 1965, Screen-print on Perspex.

An intricate, abstract pattern on the leaf of a Bromeliad looks like the pigment was dripped and poured on by Jackson Pollock

A bold abstract pattern on the leaf of a Bromeliad suggests it was painted by Rothko

Abstract Riley pattern on the leaf of a Vriesea, which has a similar optical energy

Neoregelia 'Shell dance'

During the late 1860s, early attempts by Louis Ducos de Hauron in Bordeaux using Red, Blue and Yellow filters to create colour photographs relied on three sperate colour layers and when combined the three layers produced a crude colour image. The work by de Hauron and others of this time revealed that a scattered combination of small dots of R,B,Y colours when viewed from a distance could appear to combine and produce a range of other colours. 1869 he published his work in *Les couleurs en photographie, solution du problème* and wrote "the painter does not need a palette that controls the sun, sun, employee submitted his works to give colour and life."

The grain structure of these early colour images was course, and from this, the "comma brushstroke", which became central to Pointillism, applying tiny dots of primary-colous to generate secondary colour, emerged. Pointillist painting, an offshoot of Impressionism, is often categorized as a form of Post-Impressionism. Although Georges Seurat became known as the most famous of these painters, the patterns in the skies painted by Paul Signac, are great examples of how a series of primary colour dabs can combine to produce secondary colours. In the leaves of some Bromeliads a scattering of green, red, purple pigments mixed with a trichome cover can produce a similar effect, and it is only under closer inspection the fragmented pattern is revealed where the underlying pigments are seen.

From the 1850s , at Pont-Aven, France, a new form of painting which explore the bold use of pure colour and symbolist choice of subject matter began to emerge which lasted until the beginning of the 20th century. Many of the artists were inspired by the works of Paul Gauguin who spent extended periods in the area in the late 1880s and early 1890s. It was rooted on a number of principles including the abandonment of faithful representation. In terms of the aesthetics of Bromeliads, the most interesting aspect of this was the bold application of pure colour, the absence of perspective and shading. The works began a shift into an abstraction where the shapes and relationship of colour gained a growing significance over subject matter.

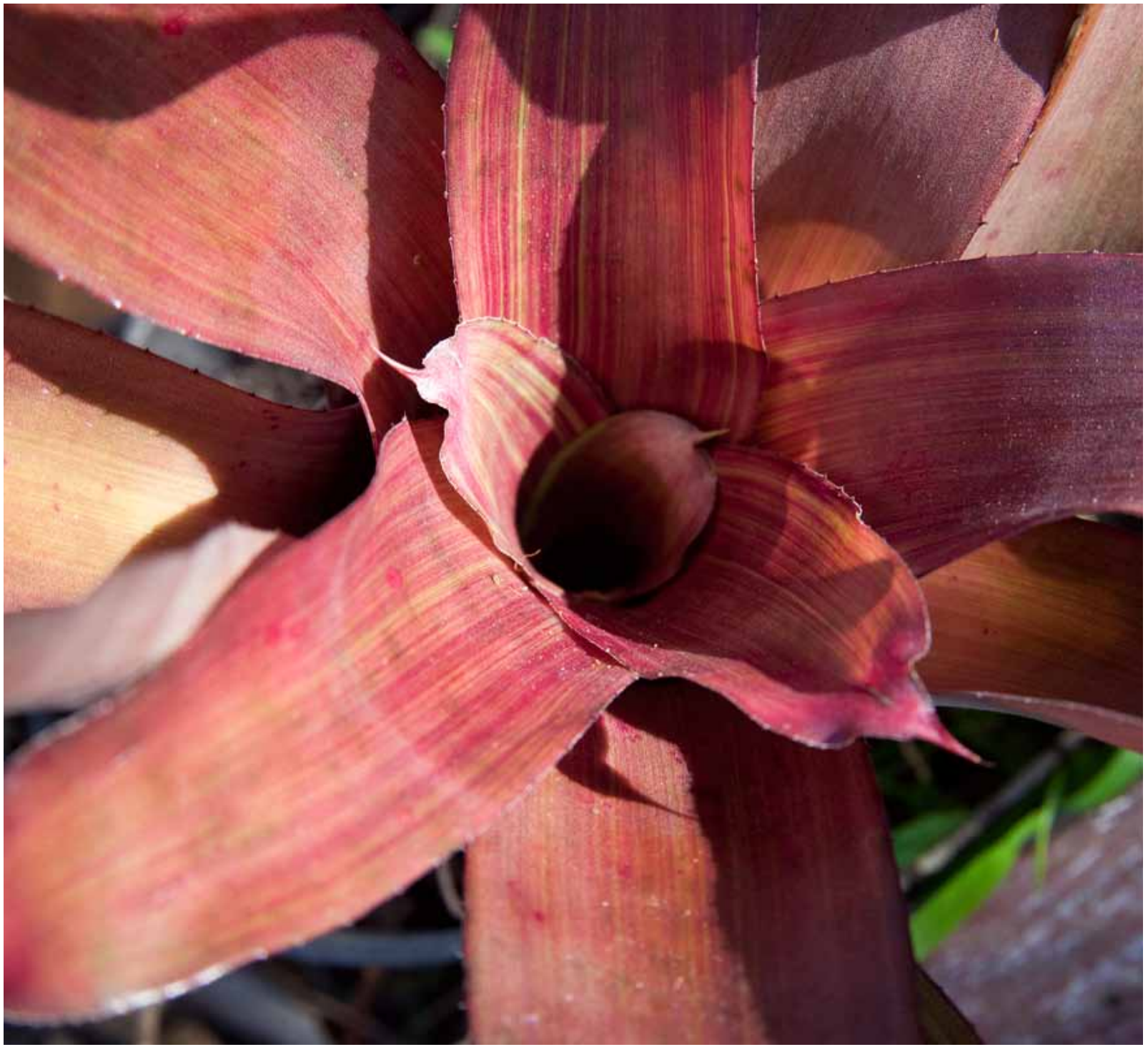
Through decades and countless "isims", abstract painting progressed through many phases. However looking at the circular composition of Robert Delaunay's painting, *Le Premier Disque*, 1912–13, it is easy to draw a link to the zonterization patterns in some plants.

Aesthetic links can be found in the linea variegated leaf patterns on many Bromeliads and the simple lines applied by Barnett Newman in his work. The painting, *Dionysius*, 1949, places parallel lines on a ground in a similar manner to the variegations that run the length of some Neoregeila and Aechmea leaves.

An attractive aspect of many broad leaf Bromeliads are the marks on the leaf surface where abstract patterns are formed similar to abstract painting. On some plants these are random shapes, splotches, dashes and dots where it is difficult to discern a repeating pattern, while on other leaves there is a stunning quite regular pattern, or large bold areas of pigmentation. Depending upon a range of circumstances, incredible patterns on the leaves can from over all the leaves, only on some leaves, or just on some parts of the leaf.

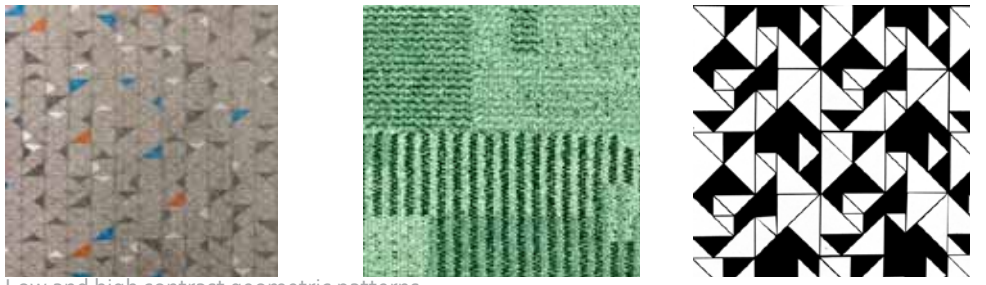
In analyzing Bromeliad leaf patterns we can draw from Pollack's intricate random expressionist pattens, the larger color fields Rothko explored, the optical patterns of Riley, the mixing of colour as in the comma brush stroke as in Signac's work.

Each of these could be applied to leaf patterns by using the terms Pollock, Rothko Riley and Signac patterns.



Neoregelia "Streaky Pete" pinstripes

In art, design and architecture we often see highly refined patterns where visual elements repeat in a predictable manner. These designers use geometry as a powerful visual tool to create repeating patterns and where high contrast is applied the pattern becomes bolder.



Low and high contrast geometric patterns

Visual patterns in nature are often chaotic and random never exactly repeating. These patterns often involve fractals where the same pattern displays at a range of scales. Natural patterns include spirals, meanders, waves, foams, tilings, cracks, and those created by symmetries of rotation and reflection and while we might see examples of these in many plant families, in Bromeliad species and hybrids we can find examples of all these natural pattern archetypes. Theodor Schwenk brilliantly presents this in the book "Sensitive Chaos".

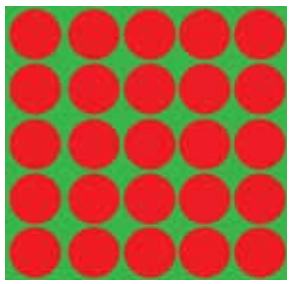
A range of random patterns - polished marble, wind blown sand and Bromeliad leaf

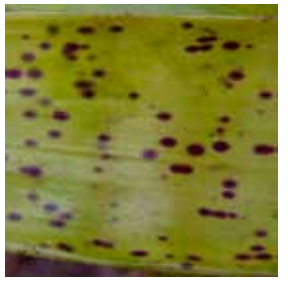
So in addition to the diverse range of colours, Bromeliads also offer an equally diverse range of leaf patterns. The image on the left shows two sets of marble flooring in a Paris Cathedral, on the left the symmetrical geometric black and white pattern is juxtaposed with the random pattern in the marble steps. Similarly, Bromeliad leaves can sometimes form two or more sets of patterns on the one leaf where the pigmentation pattern suddenly or gradually alters.

Marble pattern in a Paris Cathedral

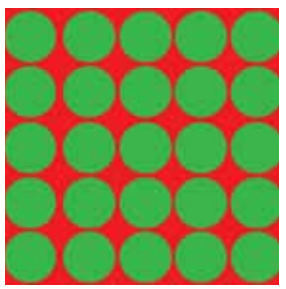
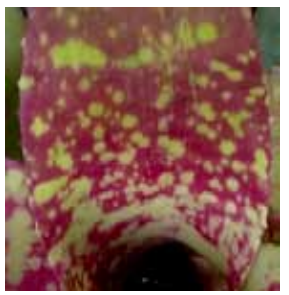
Neoregelia marble throat

An aspect of Bromeliads than many people find attractive are the incredible patterns that form on the leaf. As presented in Itten's theories, contrast of a repetitive shape against a contrasting back ground creates a strong pattern. We often see bold patterns in the leaves of some Neoregeilas with red spots against a green background. In some plants the pattern can be quite even, while in others it can be intermittent and irregular. As admirers of these plants it is often the bold pattern we immediately respond to.

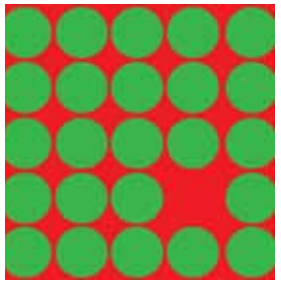




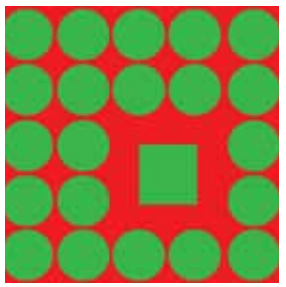
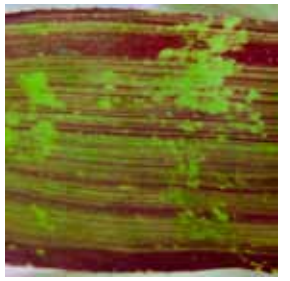
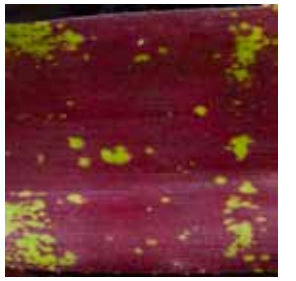
In other plants the pattern or red markings can be so profuse the red spots or marks combine to become the ground where holes appear as green spots that become figures on a red background. Interesting and crazy patterns on Bromeliad leaves are often a feature that hybridizers seek to promote through selective pollination.

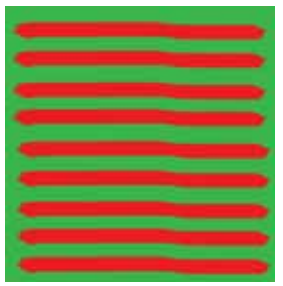

Any variation to a consistent pattern like this gap, where the green spot is missing draws the human eye to the break in the pattern. The same principle applies to the markings on Bromeliad leaves which are rarely even on the entire leaf and even less so on the whole plant. The gaps where the spots and marks are either missing or join to make larger shapes tend to draw our attention.



Like wise, the different shape within a regular pattern takes our attention. In some plants, it is the regularity of the pattern that is attractive, while in others the fragmentation of the pattern that catches our attention.

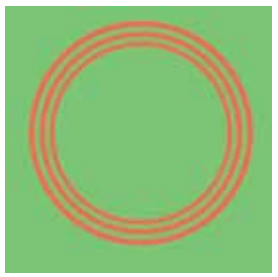




A pattern might be made up from a series of contrasting lines running parallel to each other. In Bromeliads these lines most often run down the length of the leaf following the shape of the leaf and curve in to meet at the tip. The pattern can be an obvious feature in some Aechmeas, Neoregelias, Nidulariums, Vrieseas.



Within a strong liner pattern might be conflicting lines that run in a counter direction. In some special hybrid Vrieseas and Neoregelias we see striking examples of these contrasting patterns.

Because of the rosette form of many Bromeliads, the stunning patterns appearing on each leaf blade, attain an even greater visual power when they link to form a circular pattern that runs around the rosette of tank type Bromeliads like Neoregelias.

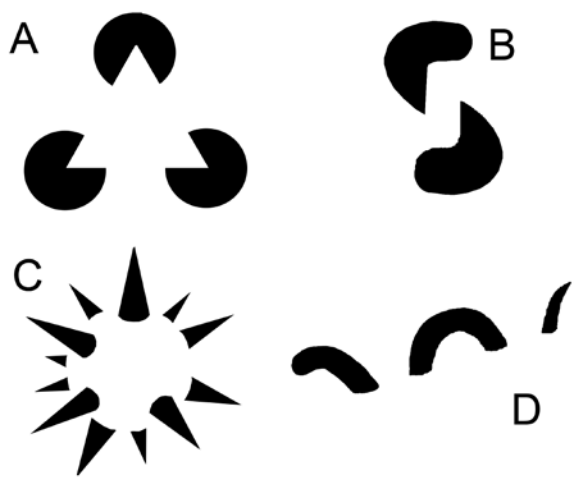


Gestalt laws of grouping

A useful way to understand how we interpret the cryptic markings on the leaves of Bromeliads is to apply fundamental Gestalt theories. (German: talt "shape, form")

The visual Gestalt laws of grouping visual elements were developed from a theory by Christian von Ehrenfels published in 1890. Through the 1930s and '40s Wertheimer, Kohler and Koffka formulated many of the laws of grouping through the study of visual perception. In essence, Gestalt psychology proposes that the human mind understands external stimuli as a whole rather than the sum of their parts, we look to make visual connections from one visual element to another and combine them to make a whole. Gestalt is rich with ideas and models like reification, and complicated by various interpretations. Often people have been exposed to intriguing graphic examples used to illustrate Gestalt without realizing what they are; like ambiguous images or reversible figures.

However, for the purpose of looking critically at Bromeliad pigmentation, four key laws will be presented: Similarity, Closure, Proximity, Continuation.



Reification is the constructive or generative aspect of perception, by which the experienced percept contains more explicit spatial information than the sensory stimulus on which it is based.

For instance, a triangle is perceived in picture A, though no triangle is there. In pictures B and D the eye recognizes disparate shapes as "belonging" to a single shape, in C a complete three-dimensional shape is seen, where in actuality no such thing is drawn.

An example of Rubin's vase an ambiguous image, two faces or a vase.

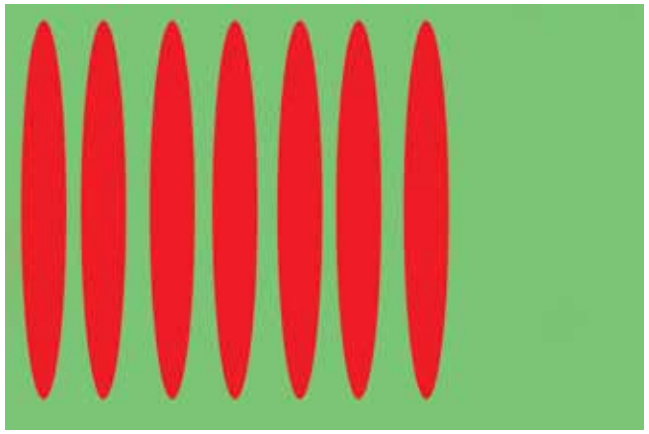
This ambiguous images figure can be seen as either a young woman or an old woman

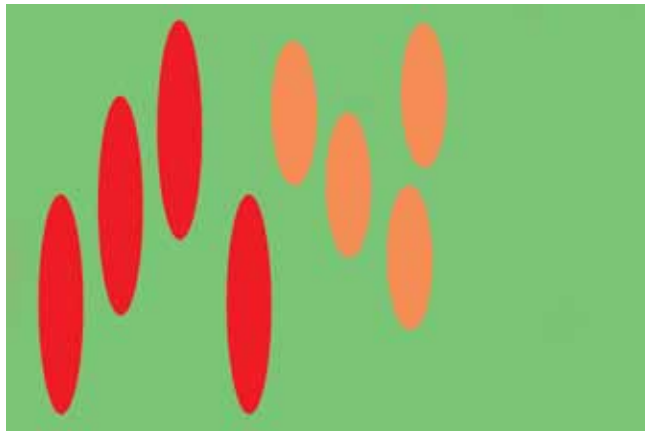
An example of reification where a white cube can be seen within the black dots

Four Gestalt Laws

Law of Similarity
The law of similarity states that elements within an assortment of objects are perceptually grouped together if they are similar to each other. This similarity can occur in the form of shape, colour, shading or other qualities. The visual strategy behind SIMILARITY is SAMENESS. With visual elements that are similar and equidistant from each other, the eye links them together and groups according to their similarity. So a group of similar elements are seen as a larger figure. The image opposite shows how a series of red lines are similar and we visually ink these together as a group. In the second example we see two sets of marks; these can be grouped as two sets through colour and size or by combining the two, one larger set is perceived through shape and contrast against the green background.

The same holds true for the cryptic marks on Bromeliad leaves.

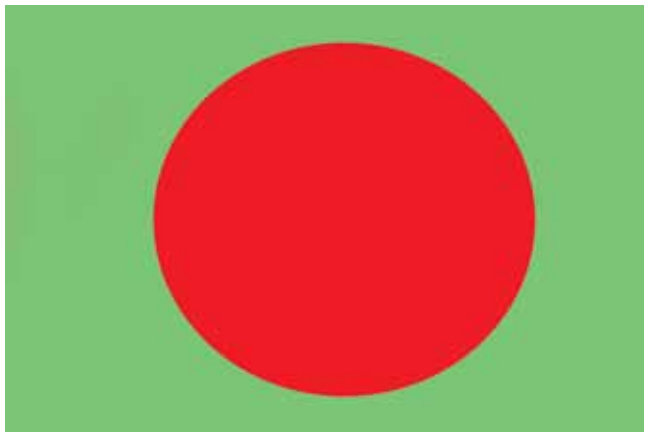


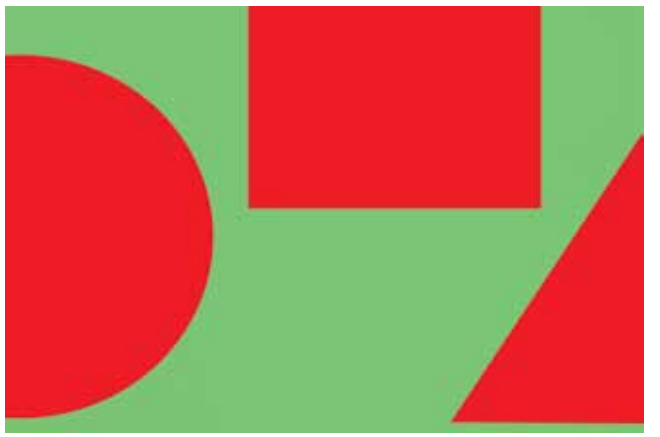


Through the law of similarity, the mind links the red lines to create a larger element on the green background

Law of Closure
The law of closure states that the human mind perceive objects such as shapes, letters, pictures, as being whole when they many be visually incomplete. Specifically, when parts of a whole picture are missing, our perception fills in the visual gap. Research shows that the reason the mind completes a regular figure that is not perceived through sensation, is to increase the regularity of surrounding stimuli. For example, in the top examples it is easy to perceive a full and closed circular figure.

However in the illustration below this, the law of closure proposes that, even though gaps are present in the shapes, we perceive a full circle on the left side of the image, a rectangle at the top and a triangle on the right side of the image. The visual strategy behind CLOSURE is SHAPE. Here, closed visual elements are seen as figures - by this we mean shapes. They might form large dominant areas that we can use to structure the image. Again this holds true in the abstract marks on the leaves of plants.



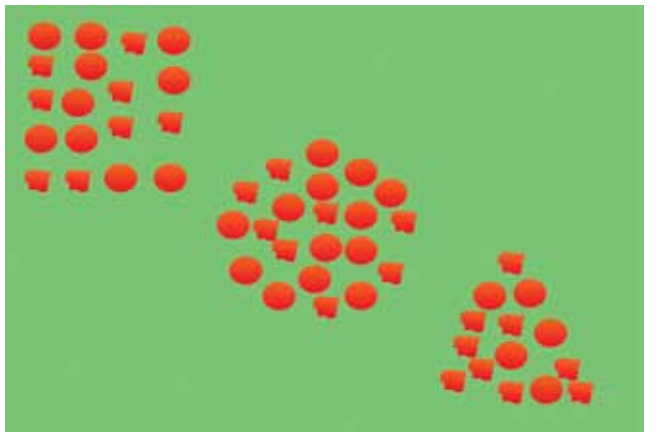


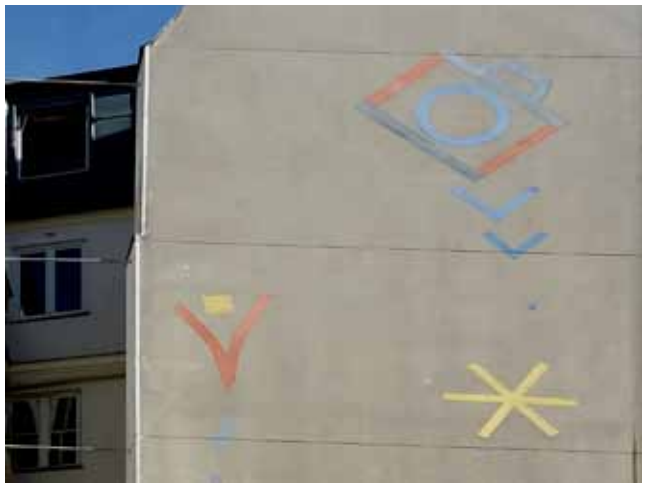
The fine strands of seaweed in the pool combine to create a strong closed shape.

Although the reflective dome is broken by the silhouette of the tree trunk through the law of closure we link the shape and complete a closed form

Law of Proximity
The law of proximity states that when the mind perceives an assortment of visual elements the are quite different, yet arranged close to each other, the mind can link these and perceive the separate elements as forming a group. For example, in the illustration we see a series of different red marks combining to form a square, circle and triangle. Then these three larger shapes combine to create diagonal running from top left to bottom right.

The abstract pigmentation on Bromeliad leaves can work in a similar manner, we can sense the overall form of the plant, the shape of the leaves and then the intricacies of any pattern in the leaf.



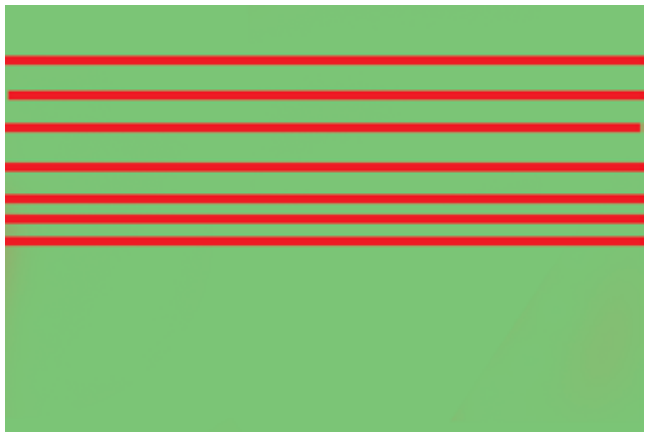


The different paint motifs on the wall combine to create a triangle

Law of Continuity
The law of continuity states that visual elements within larger objects tend to be grouped together, and therefore integrated into perceptual wholes if they are aligned within an object.

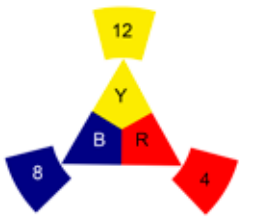
The visual strategy behind CONTINUITY is LINE. Here visual elements are grouped to from continuous straight or curved lines. The eye wants to follow lines in an image and where there are gaps the mind willingly joins these up across the break to continue the visual flow of the line. In an image or photograph, the simplest form of continuity is a single straight line, which can be on a diagonal and though perspective can diminish. The line might also curve as in a pathway or road, and many painters, graphic artists and photographers use this as an effective means of leading the eye to a focal point.

In the leaves of Bromeliads we see particularly strong examples in the variegated leaves of Aechmeas, Neoregelias, Nidulariums, Vrieseas where bold variegated stripes run the entire length of the leaf.



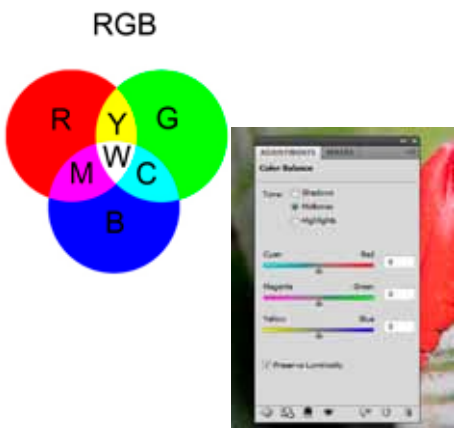
Colour theory

As there are many different colour systems, which can lead to confusion; so defining what system of colour is appropriate is necessary.



Aesthetics and Design
This is the system artists like painters use when composing a painting. In aesthetics we are looking at the design relationships of colours within an image - a photograph, print, painting. We have Red, Blue and Yellow as the primary colours, each colour has a visual weight and we can critically analyse the association of these colours in an image Red, Blue, Yellow, those colours we learn about as children.

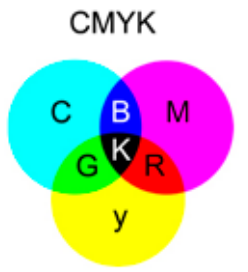
Photoshop
In the digital age many people are familiar with applications like Photoshop, but here the colour system is different. In Photoshop we are concerned with light and the control of colour within the digital image. Here the primary colours are; Red, Green, Blue, while at the opposite end of the slider control are the secondary colours, Cyan, Yellow, Magenta. These colours are opposite each other for a reason.



- Cyan is opposite red because there is no red in cyan
- Magenta is opposite green because there is no green in magenta
- Yellow is opposite blue because there is no blue in yellow

It is easy to confuse this digital system of controlling colour with the RBY system above for designing and critiquing colour within an image or the leaves of a Bromeliad. However in some circumstances photoshop can be a useful tool in analysing the colours on the leaf of a plant.

Photographic colour enlarging & printing
To further confuse colour systems, the Printers' color triangle is the set of colors used in the printing process to reproduce images. Here the primaries are magenta, cyan, yellow and K. The "K" in CMYK stands for key because in four-color printing, cyan, magenta, and yellow printing plates are carefully keyed, or aligned, with the key of the black key plate.

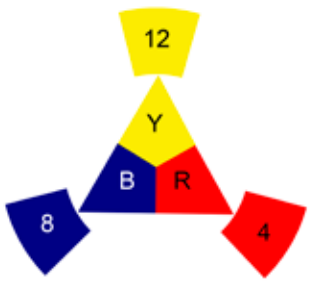


Painting
However,unlike mixing light as in photoshop or in enlarging, with graphic arts like painting when we mix the three primary colours red - blue - yellow we have a drab brown.

Red Blue Yellow Colour Wheel

For the exercise of looking at Bromeliad colours we will use Red, Blue, Yellow and call the colours HUES. To explore this deeper a colour wheel (also referred to as a colour circle) is useful. This is a visual representation of colours arranged according to their chromatic relationship.

The first step in the colour wheel is positioning the primary HUES, Red - 4, Blue -8 , Yellow - 12, equidistant from one another, then create a bridge between primaries using secondary and tertiary colours. Primary hues are those colors that cannot be created by mixing other colours or hues. Perhaps we witness the most explicit examples of RBY designs in the abstract orthogonal work of Piet Mondrian like "*Victory Boogie Woogie*" (1942–44) where he plays with the primary colours in grid designs. Although nature's colour designs are never precise and simple as three primary colours, Bromeliad leaves can produce red and yellow pigments, but never a pure blue as Mondrian uses. However some flowers do produce a range of blues in the petals. When expanded to secondary and tertiary colours, R,B,Y is a useful system to gain an understanding of the colour relationships within the patterns on Bromeliad leaves.



Secondary Colors: Those colors achieved by a mixture of two primaries. Red yellow creates orange -2, red blue creates violet - 6, blue yellow creates green - 10. Fauvism was an art movement that is distinguished by intense and pure colors that are put directly onto the canvas. The application of primary and secondary colour is in Fauvism is seen in the painting *La Musique*, by Henri Matisse, 1939.

Tertiary Colors: Those colors achieved by a mixture of primary and adjacent secondary hues.
Yellow orange - 1, orange red -3, red violet - 5, violet blue - 7, blue green - 9, green yellow 11. Combined tertiary, secondary and primary colour offer a greater spectrum of colour that we can apply to Bromeliad pigmentation. "Art is not nature... *There was a lot more to be got out of color."* Pierre Bonnard. For Bonnard, color was an end in itself - a way of experiencing the world. Color was so important to Bonnard that when he had mixed a color that was particularly to his liking, he would even go back and touch up other paintings with that color. He once persuaded his friend Édouard Vuillard to distract one of the guards in a museum while he touched up a work that had been completed years previously.

Describing colours

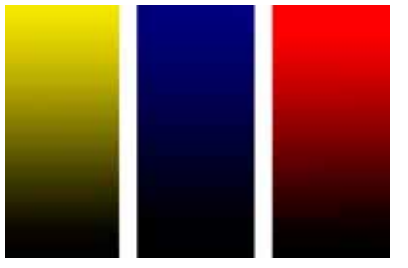
Across various colour systems sophisticated ways of describing colour have been developed which appear to describe the same thing or contradict, the include :
Chroma: How pure a hue is in relation to gray
Saturation: The degree of purity of a hue.
Intensity: The brightness or dullness of a hue. One may lower the intensity by adding white or black.
Luminance / Value: A measure of the amount of light reflected from a hue. Those hues with a high content of white have a higher luminance or value. Shade and tint are terms that refer to a variation of a hue. Although pink, crimson, and brick are all variations of the color red, each hue is distinct and differentiated by its chroma, saturation, intensity, and value. Chroma, intensity, saturation and luminance/value are inter-related terms and have to do with the description of a color.
Shade: A hue produced by the addition of black.
Tint: A hue produced by the addition of white.

All this can suddenly seem complex, confusing an unnecessary in looking at the colour of Bromeliads so I will aim to present a simple system that can be applied.

With further mixing of adjacent colours intermediate colour hues are generated, to expand the colour wheel to 24 colours.

By lightening each of these colours in a series of incremental steps, the wheel is expanded into a larger spectrum. Works painted in this colour spectrum are said to be high key. Artists like James McNeill Whistler used a palette like this in the painting *Note in Blue and Opal*, 1884.

By darkening each of these colours again in incremental steps the spectrum is expanded further. Works painted in this colour spectrum are said to be low key. The dark moody painting, *The Bell Rock Lighthouse*, 1819, by J.M.W.Turner is an example.



When all of these incremental steps are combined a full spectrum is generated.


Y
O
G
R
B
V

Visual weight

When we place areas of colour next to each other, each colour element is said to have a visual weight. This is a value based on the relative importance the human mind affords it and different systems have been devised to understand and apply these theories.

In designing harmonious relationships an artist might place a small area of light value against a larger area of a heavier value. To experiment with visual disharmony the relationship might be reversed. While artists and designers look at how colours relate to each other on the colour wheel, and certain theoretical combinations can be set up, it is not enough to say they are harmonious. Each colour has an intrinsic brightness, so complete balance requires that the combinations are seen in certain proportions.

There is a difference in brightness among the six colours, (primary and secondary) and the brightness relates to the visual weight each carries. In descending order the generally accepted light values Determined by J.W. von Gothe, the German Poet and playwright, are:

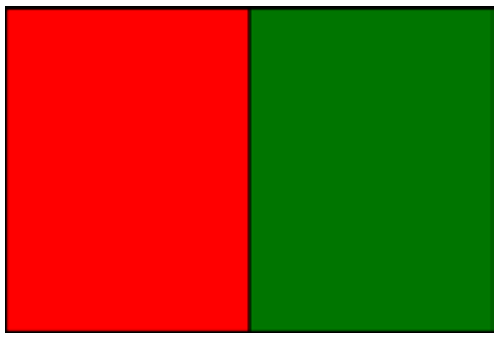
yellow 9 - orange 8 - red and green 6 - blue 4 - and violet 3.

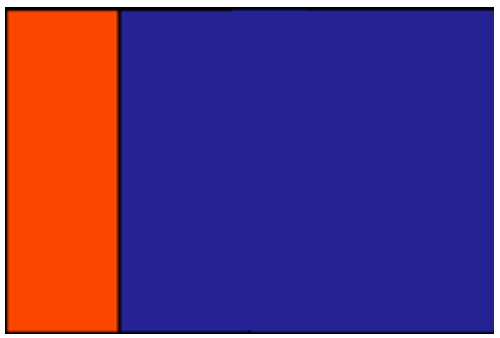
When they are combined the relative values must be reversed - so that violet occupies a larger area to compensate for it lack of strength. The areas need for each of these colours are therefore-

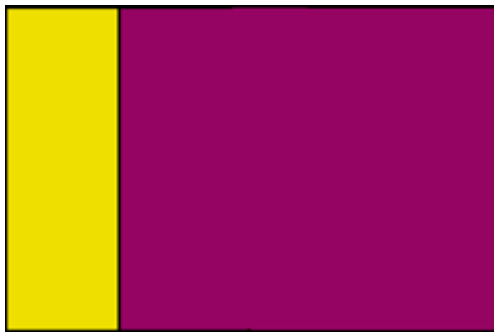
Violet 9 - blue 8 - red and green 6- orange 4 - yellow 3

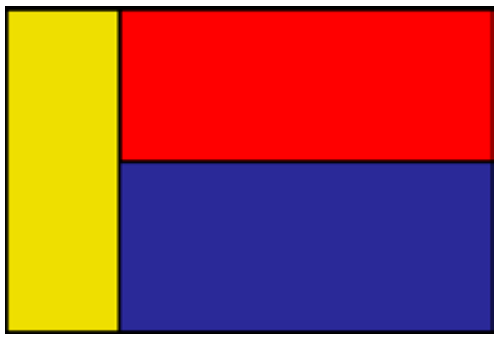
Artists have experimented with these theories, playing by the rules and also deliberately breaking the rules and the illustrations demonstrate how colour can be arranged via weight.

In looking at the leaves of Bromeliads these theories become complicated by which elements we look at, a leaf, a series of leaves or the whole plant, and the fact that the colour can not be arranged, only commented on. However the colour arrangements in the illustrations indicate ways of using colour and visual weight to look critically at the weight of red and green elements on a leaf, or the over all arrangement of a Bromeliad rosette. In terms of red green balance, a leaf pattern can be said to have a harmonious or disharmonious colour relationship.









Complementary Relationship Those colors across from each other on a color wheel.

Active & passive colour

The color wheel can be divided into two ranges that are visually active or passive. Active colors will appear to advance when placed against passive hues. Passive colors appear to recede when positioned against active hues. Advancing hues are most often thought to have less visual weight than the receding hues. Most often warm, saturated, light value hues are "active" and visually advance. Cool, low saturated, dark value hues are "passive" and visually recede. Tints or hues with a low saturation appear lighter than shades or highly saturated colors. From the chart it is easy to see how contrasting passive greens against active reds on the leaves and flowers of some Bromeliad attract attention. Theoretically, some colors between the active range and passive remain visually neutral or indifferent.

Monochromatic Relationship: Colours that are shade or tint variations of the same hue. We see this in the green leaves of some Bromeliads. *Blue Nude*, 1902, is one of Pablo Picasso's master pieces. He used a sombre blue pallet when one of his close friend tragically died, he mourned for a long time and was in a depressive mode. From his blue period, the painting proved Picasso's talent on highlighting the deepest emotions through the use of a monochromatic scale. In a contemporary context, Gerhard Richter's painting, *September,* Catalogue Raisonné: 891-5, also shows the use of a monochromatic scale.

Complementary Colours: Those colours located opposite each other on a colour wheel. Complementary colours are pairs of colours that contrast with each other more than any other colour, and when placed side-by-side make each other look brighter In the 1880s, a colony of artists including , Paul Gauguin and Paul Se'rusier, gathered in Pont-Aven Brittany where they rejected current theories favouring simplified forms and flat planes of colour in what was known as the Pont-Aven School. Gauguin refined the use of complimentary colours to give vibrancy and intense colour in his paintings. In Bromeliad flowers and leaves, we often observe strong complimentary colour. The green leaves of Neoregelias that transition to saturated red in the centre are examples of a complimentary colours arrangement as are the juxtaposition of green leaves to the vibrant red flower spikes of some Vrieseas.

Analogous Colours: Those colours located close together on a color wheel. Some Neoregelias develop leaves with analogous colour.

Split-Complementary Relationship: In this arrangement, one hue plus two others equally spaced from its complement.

Double-Complementary Relationship: Two complementary color sets; the distance between selected complementary pairs will effect the overall contrast of the final composition.

Analogous Relationship: Those colors located adjacent to each other on a color wheel

Triad Relationship: Three hues equally positioned on a color wheel.

Red

Not surprisingly, Red is one of the most powerful colours - it immediately attracts visual attention. We see this in the leaves of many Bromeliads particularly the vibrant reds associated with flowering in Neoregelias and Nidulariums.

Red is actually the longest wave length and when set against cooler colours, green in particular red advances forward towards the viewer.

It has considerable visual energy in any image and produces very strong vibrations against other colours. In contrast to the transparency and luminosity of yellow, red is relatively dense and solid. It can be moved a long way towards orange or violet and still be seen as a essentially the same colour. At the far end of its bluish range, it produces a variety of exotic hues, including magenta and purple. Even when adulterated towards russet or when darkened it remain recognizable. While yellow can be felt to radiant light, red radiates the most energy.

Red is the color of fire and blood, so it is associated with energy, war, danger, strength, power, determination as well as passion, desire, and love. Red is a very emotionally intense color. It enhances human metabolism, increases respiration rate, and raises blood pressure. It has very high visibility, which is why stop signs, stoplights, and fire equipment are usually painted red. In heraldry, red is used to indicate courage. It is a color found in many national flags.

Light red represents joy, sexuality, passion, sensitivity, and love. Pink signifies romance, love, and friendship. It denotes feminine qualities and passiveness. Dark red is associated with vigor, willpower, rage, anger, leadership, courage, longing, malice, and wrath.Reddish-brown is associated with harvest and fall.

Brown suggests stability and denotes masculine qualities.

We see these emotional associations reflected in the names of many hybrid Neoregelias like *Neoregelia blood red, Neoregelia born of fire, Neoregelia born of fire, Neoregelia furnace, Neoregelia scorcher, Nidularium procerum ruba, Alcantarea imperialis rubra, Aechmea nudicaulis rubra, Aechmea Red Bands.*

Hybrid #4 - *Neoregelia oldsmobileii cutlassae supremea sedanus*

Blue

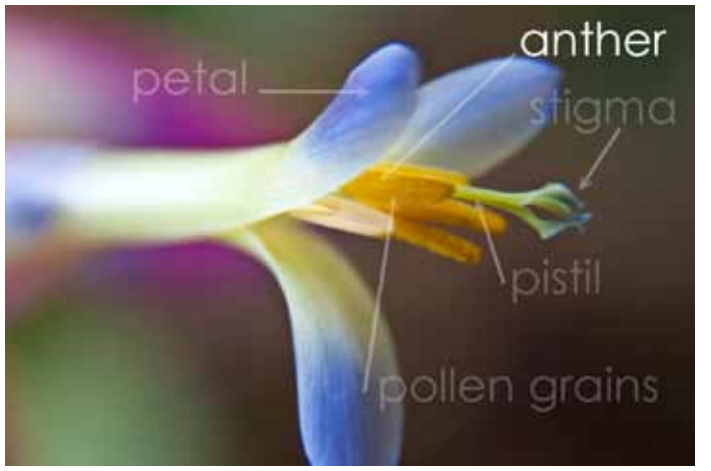
Blue recedes visually, it is much quieter and less active than red. Of the three primary colours it is the darkest colour, and it has its greats impact when deep. It has a transparency that contrasts with reds opacity. This is why it works well as a colour for misty and hazy landscape subjects. Although blue tends towards neither green nor violet, it has a considerable latitude, and is a hue that can be difficult to discriminate. Identifying a pure exact blue is more difficult than identifying Red or Yellow. Expressively Blue is used to reference coolness.

Blue is the color of the sky and sea. It is often associated with depth and stability. It symbolizes trust, loyalty, wisdom, confidence, intelligence, faith, truth, and heaven. Blue is considered beneficial to the mind and body. It slows human metabolism and produces a calming effect. Blue is strongly associated with tranquility and calmness. In heraldry, blue is used to symbolize piety and sincerity. Blue is a masculine colour; according to studies, it is highly accepted among males. Dark blue is associated with depth, expertise, and stability; it is a preferred colour for the corporate world.

You can use blue to promote products and services related to cleanliness (water purification filters, cleaning liquids, vodka), air and sky (airlines, airports, air conditioners), water and sea (sea voyages, mineral water). As opposed to emotionally warm colors like red, orange, and yellow; blue is linked to consciousness and intellect. Use blue to suggest precision when promoting high-tech products.

While Bromeliads, like all plants do not produce pure blue in their leaves, some species and hybrids do produce a range of blues in the petals of flowers, which can be seen in Aechmeas, Billbergias, Neoregelias, Nidulariums and Tillandsias. As Bromeliad flowers are small, blue is a colour one normally does not associate with these plants. However a closer inspection of flowering plants can reveal delicate arrangements. *Aechmea cylindrata* is an example.

Some hybrids that use blue in the name are, *Neoregelia picasso blue nude, Neoregelia blue centre, Neoregelia blueberry tiger, Aechmea blue cone, Achmea blue rain.*



Yellow

Yellow is the brightest and lightest of all the colours and in fact does not exist in a darkened form unless degraded, that means with grey, black or white added.

The darkest pure yellow is brighter than any other colour so it projects forward more than any other colour. It is most often found against darker colours it seems to radiate out of the picture

Yellow is the colour of sunshine. It's associated with joy, happiness, intellect, and energy.

Yellow produces a warming effect, arouses cheerfulness, stimulates mental activity, and generates muscle energy. Yellow is often associated with food. Bright, pure yellow is an attention getter, which is the reason taxicabs are painted this color. When overused, yellow may have a disturbing effect; it is known that babies cry more in yellow rooms. Yellow is seen before other colors when placed against black; this combination is often used to issue a warning. In heraldry, yellow indicates honor and loyalty. Later the meaning of yellow was connected with cowardice. Use yellow to evoke pleasant, cheerful feelings. You can choose yellow to promote children's products and items related to leisure. Yellow is very effective for attracting attention, so use it to highlight the most important elements of your design. Men usually perceive yellow as a very lighthearted, 'childish' color, so it is not recommended to use yellow when selling prestigious, expensive products to men – nobody will buy a yellow business suit or a yellow Mercedes. Yellow is an unstable and spontaneous color, so avoid using yellow if you want to suggest stability and safety. Light yellow tends to disappear into white, so it usually needs a dark color to highlight it. Shades of yellow are visually unappealing because they loose cheerfulness and become dingy.

In Bromeliads, some plants with striking yellow foliage are; *BILLBERGIA 'Foster's Striate', Nidularium Miranda, Alcantarea glaziouana 'Variegated'* while the flowers and inflorescence of some Vrieaea like *Vriesea Carinata, Vriesea flava, Vriesea inflata* offer great yellows. Plants like Aechmea "Pie in the Sky", *Aechmea cuculata* produce small but bright yellow flowers.

Alcantarea 'John Stodart' is a fantastic plant with a variegata variety with a wide vibrate yellow stripe. It is a large plant which can grow to nearly 2 metres and it is listed in Seabreeze nurseries catalogue as "The rarest and most expensive Bromeliad we sell".

Green

Between yellow and blue, green has the widest distinguishable range of colours. It can quite take on many different forms depending upon how yellow or blue it is. Although of medium brightness, green is the most viable of colours to the human eye. - at low light levels of illumination, we can see better by green light than any other wavelength.

Green is the key colour of nature, and its associations and symbolism derive principally with this. Plants are green therefore it is the colour of growth and by association it is a positive colour - with suggestions of hope and progress. For the same reasons, yellow - green has spring like associations of youth .

Green is the color of nature. It symbolizes growth, harmony, freshness, and fertility. Green has strong emotional correspondence with safety. Dark green is also commonly associated with money. Green has great healing power. It is the most restful color for the human eye; it can improve vision. Green suggests stability and endurance. Sometimes green denotes lack of experience; for example, a 'greenhorn' is a novice. In heraldry, green indicates growth and hope. Green, as opposed to red, means safety; it is the color of free passage in road traffic.

Bromeliad leaves produce a wide range of greens the subtleties of which are often overlooked or only seen as a colour where other more vibrate pigments like red are juxtaposed against.

The amazing cryptic patterns *of Vriesea hieroglyphica* are largely within the green pigments.

Orange

As a mixture of red and yellow, orange absorbs some of the qualities of both colours. It is brilliant and powerful when pure and since yellow radiates light and red energy, it is very much by association a colour of radiation When lighter as in pale beige and darker as brown it has neutral warmth. Orange is the colour of fire and of late afternoon sunlight. It has association with festivity and celebration - but also of heat and dryness.

Symbolically it can be changed with yellow for the sun and red for heat Orange combines the energy of red and the happiness of yellow. It is associated with joy, sunshine, and the tropics. Orange represents enthusiasm, fascination, happiness, creativity, determination, attraction, success, encouragement, and stimulation. To the human eye, orange is a very hot color, so it gives the sensation of heat. Nevertheless, orange is not as aggressive as red. Orange increases oxygen supply to the brain, produces an invigorating effect, and stimulates mental activity. It is highly accepted among young people. As a citrus color, orange is associated with healthy food and stimulates appetite. Orange is the color of fall and harvest. In heraldry, orange is symbolic of strength and endurance.

Orange has very high visibility, so you can use it to catch attention and highlight the most important elements of your design. Orange is very effective for promoting food products and toys.
Dark orange can mean deceit and distrust.
Red-orange corresponds to desire, sexual passion, pleasure, domination, aggression, and thirst for action.
Gold evokes the feeling of prestige. The meaning of gold is illumination, wisdom, and wealth. Gold often symbolizes high quality.

Nidularium Fulgens (orange), Aechmea nudicaulis aequalis, Neoregelia orange tart

Violet

The mixture of red and blue stands out amongst colours as being the most elusive of all. Many people have great difficulty distinguishing violet, often selecting purple. Pure violet is the darkest colours. When light it becomes lavender, and when very dark it can be confused with dark blue and blue black. If reddish it tend towards magenta - if less red it simply merges with blue.

Purple combines the stability of blue and the energy of red. Purple is associated with royalty. It symbolizes power, nobility, luxury, and ambition. It conveys wealth and extravagance. Purple is associated with wisdom, dignity, independence, creativity, mystery, and magic.

According to surveys, almost 75 percent of pre-adolescent children prefer purple to all other colours. Purple is a very rare colour in nature; some people consider it to be artificial.

Light purple is a good choice for a feminine design. You can use bright purple when promoting children's products.

Light purple evokes romantic and nostalgic feelings.
Dark purple evokes gloom and sad feelings. It can cause frustration.

In the Western Culture: Purple and gold are often associated with Royalty, wealth and opulence

Plants like *Neoregelia australian affair, Neoregelia morado*, *Neoregelia mr irresistible*, *Neoregelia Voodoo Doll* can produce a range of violet purple colours in the leaf.
While plants like *Aechmea weilbachii* produce vivid violet purple colours in the flower petals

Hybrids with names like *Neoregelia purple pauline, Neoregelia 'America Purple Mountain Majesty'* are suggestive of the colours produced by Bromeliads within this colour range.

White

White is associated with light, goodness, innocence, purity, and virginity. It is considered to be the color of perfection.

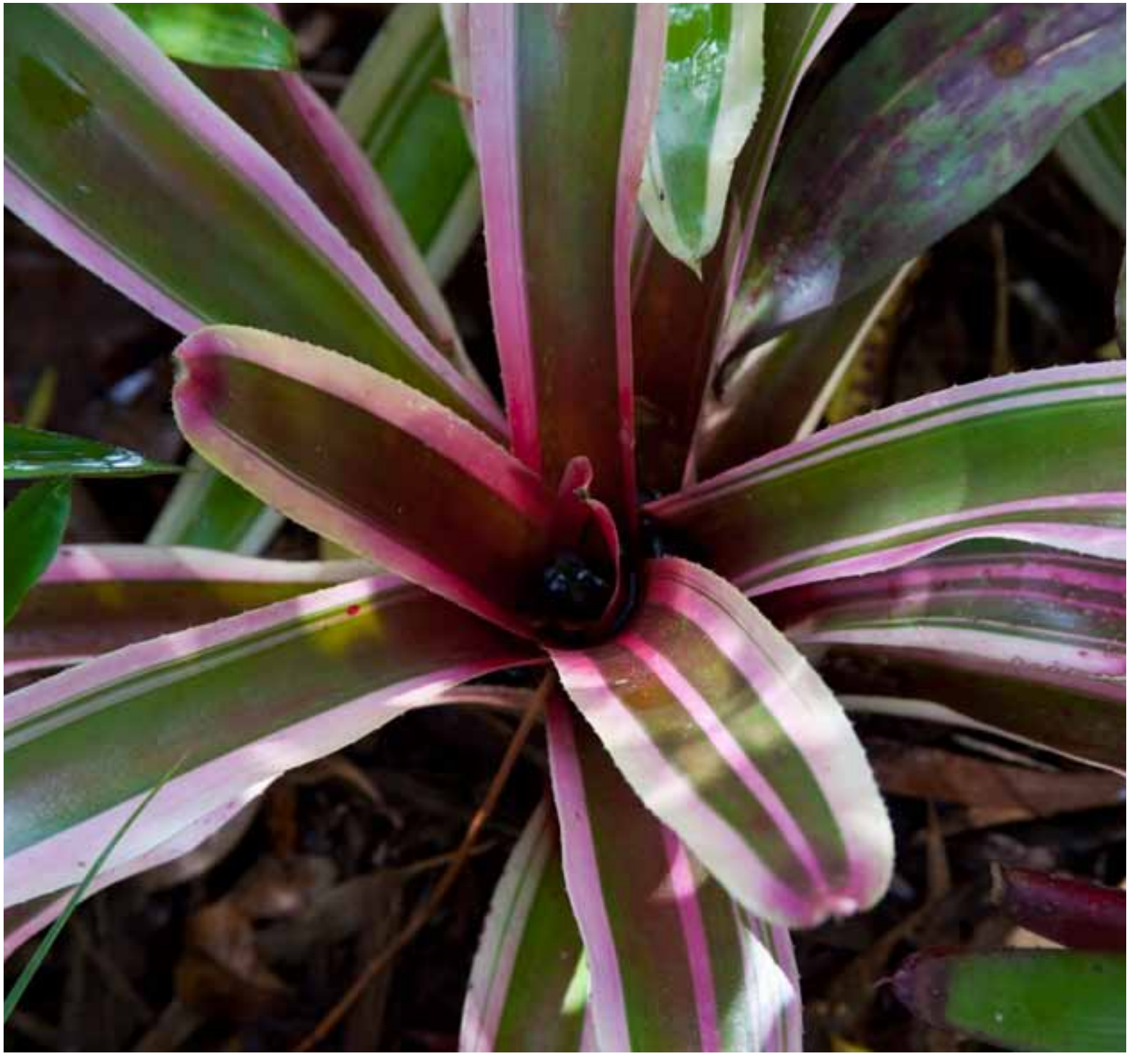
White means safety, purity, and cleanliness. As opposed to black, white usually has a positive connotation. White can represent a successful beginning. In heraldry, white depicts faith and purity.

In advertising, white is associated with coolness and cleanliness because it's the color of snow. You can use white to suggest simplicity in high-tech products.

White is an appropriate color for charitable organizations; angels are usually imagined wearing white clothes. White is associated with hospitals, doctors, and sterility, so you can use white to suggest safety when promoting medical products. White is often associated with low weight, low-fat food, and dairy products.

As mentioned earlier, in the leaves of Bromeliads white is created by variegations where there is no chlorophyll. Through hybridizing, growers of Bromeliads often foster these stunning combinations where the bold contrast of white offers a bold contrast against the green pigment.

Some varieties where there is a wonderful play of white, green and sometimes red include: *Neoregelia "Fire Ball" Variegated, Neoregelia Groucho, Neoregelia 'Stella Blast', Neoregelia 'Alcatraz', Neoregelia Ardie , Aechmea Old Stripey, Quesnelia arvensis medio-picta*



Bromeliad leaf patterns

As mentioned in the introduction, the book, *Growing Bromeliads* compiled by the Bromeliad Society of Australia, published by Kangaroo Press offers an explanation to the leaf patterns of Bromeliads. I also mentioned expanding these descriptions.

A frustrating aspect of placing Bromeliad leaves in "boxes" is sometimes they never seem to fit exactly, the patterns match for one or two leaves then break the system for other leaves that form the rosette. Aspects of each appear to overlap and become combinations. So these categories should be seen in generalized terms.

Following is a list of these.

The translucent colour patterns of Chihuly's open bowl glass works - or Intricate pottery glazes

uniformis: this is the simplest pigmentation in the leaves of Bromeliads, here the leaf is a single colour, most often green, but it can also include other pigmentations. Bromeliads with a uniform leaf colour can easily be over looked by collectors, but plants with these monochromatic relationships have their own refreshing qualities and in landscaping can often provide stable backgrounds to accent other more dramatic plants against.

While pigmentations in the leaf can appear uniform when viewed from above positioning the leaf to allow the light to transmit through it and afford a degree of translucency can reveal variations in the pigmentation. In the case of plants like *Aechmea organensis*, on closer examination the leaf often contains a range of subtle colour variations.

graduatus: where the colour of the leaf gradually shifts from one colour to another. This happens can happen in Neoregelias. The gradual colour change can run up the length of the leaf, across the leaf, on the top or bottom surface.

repens: Abrupt sudden, in some Neoregeila leaves the pigmentation abruptly changes colour as in a hard line.

MUCRO: sharp point, edge, dagger point, here the very tip of the leaf is a contrasting colour nearly always redder or darker. Some Neoregeilias produce strong examples of a bright red maroon pigmentation against the over all green of the leaf, while other plants like *Neoregelia noble descent* with mixed red green pigmentation produce a band of green near the end which is punctuated with the red tip.

The effect can be a dramatic sharp contrast or as in the tips of some plants like *Vriesea fosteriana x platynema* where a gradual darkening at the tip occurs. Other plants with this trait - *Neoregelia gee whiz*,

pessum: to the ground, to the bottom, downward, the bottom or base of the leaf on the underside of the leaf. Because of the rosette shape of many plants this often not visible from above as it faces outwards

Variegata: Irregularly colored or blotched; but in Bromeliaceae generally accepted as longitudinally striped. In Bromeliads, there are so many variations of this pigmentation that it has been broken down into more specific terms, so that Variegated or variegata means the leaf edge is green and the middle area white or yellow. Variegata occurs in Aechmea, Billbergia, Neoregelia, Vriesea. Some plants can produce this effect over the entire plant, or on only a few leaves where there are multiple lighter pigmentation strips.

marginata: is a form of Variegation usually albo-marginata, meaning the white or lighter colour is at the edge of the leaf, while the central leaf zone remains solid green.

striata: A form of variegation - striped; marked with longitudinal lines, where the foliage is green overlaid with longitudinal white or yellow stripes of varying widths.

lineata: a form of Variegation with thin lines or stripes.

The narrow spacing between liner pigments is reminiscent of Gerhard Richter's strip paintings on a transparent medium. *Strip 2011 Catalogue Raisonné: 920-4* is an example.

Medio-picta: a form of variegation where the center of the leaf is a whitish colour

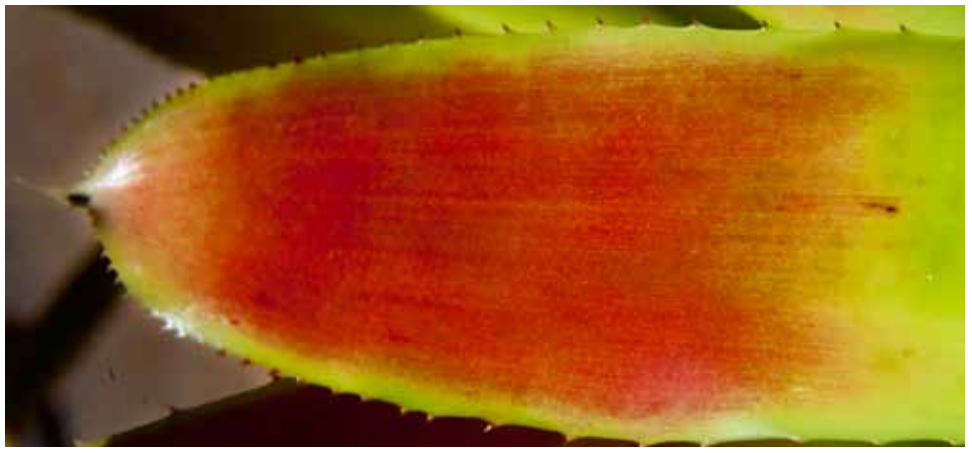
paxianum: With green leaf margins and a single , broad white strip

bivittatus: a form of variegation where the leaf is doubly striped lengthwise

unum aciem tenuem - a form of variegation with a single thin line or a series of thin lines in the centre.

plagis vermiculus - a form of variegation with red or crimson stripes running down the length of the leaf.

Fimbriae - fringe, edge, extremity, border - as in this leaf with a green edge - the Anthocyanins (red pigments) are formed in the center with a distinct green edging that runs up the length of the leaf.



tricolor: a form of variegation with three colours usually green, cream and pink

quadricolor : Four (quadricolor = four-colored.

marmoration: variegated with a superimposed swirled pattern of one colour on another so as to resemble the patterns one might see in marble formations.

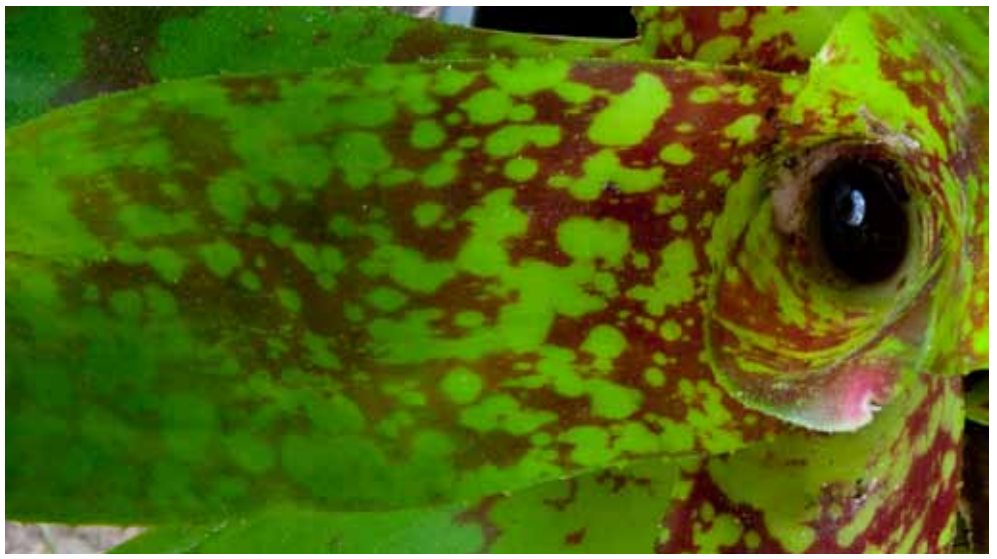
Marble is a metamorphic rock that forms when limestone is subjected to the heat and pressure of metamorphism and while it can be of one colour, it can also present in amazing color patterns. The variety of colours exhibited by marble are a consequence of minor amounts of impurities being incorporated with the calcite during metamorphism and this is referenced in the name. While in visual arts hand made marbled paper was often used as part of the inside covers of a book, artists like Robert Wu, have used the print making technique in more creative ways. As Wu's "*Phoenix Rising*" suggests the swirled ink patterns are similar to those found in some marble deposits, and the leaves of some Bromelids like *Neoregelia Marmorata*.

Neoregelia Marmorata

concentric: with intensification of color in the center of the plant as in *Neoregelia concentrica*. Many Neoregeilas produce vivid colour in the centre

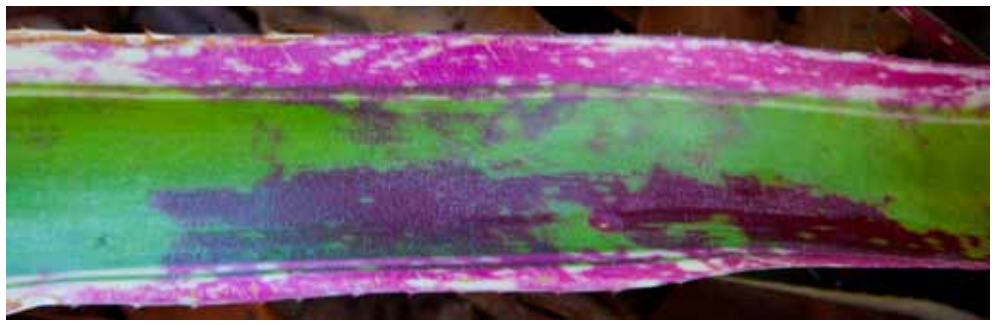
maculation: Spotted; blotched; marked with spots. The markings or figures are red spots of blotches on a green ground, which is usually more predominant in the center of the plant. This patterning is obvious in many Neoregelias.

maculation reversed: Spotted; blotched; marked with spots. The markings or figures are green spots of blotches on a red ground which is usually more predominant in the center of the plant



fenestralis: With window-like openings; referring to the light-green rectangular areas on leaves which give the illusion of windows. Many hybrid Vrieseas produce some amazing fenestralis patterns. These patterns do not run as even pigmentation gaps across the leaf buy more as broken zigzag lines much like the optical patterns in some of Bridged Riley's Op Art works. The translucent nature of some leaves bring to mind the stunning colour patterns of Chihuly's open bowl glass works.

Iacio: to throw, cast, hurl, lay, scatter, diffuse, here the contrasting pigmentation is scattered randomly across the leaf. So rather than show as a series of spots, dots or blotches it shows as larger splashes which appear to have been scattered across the leaf like spilled ink.



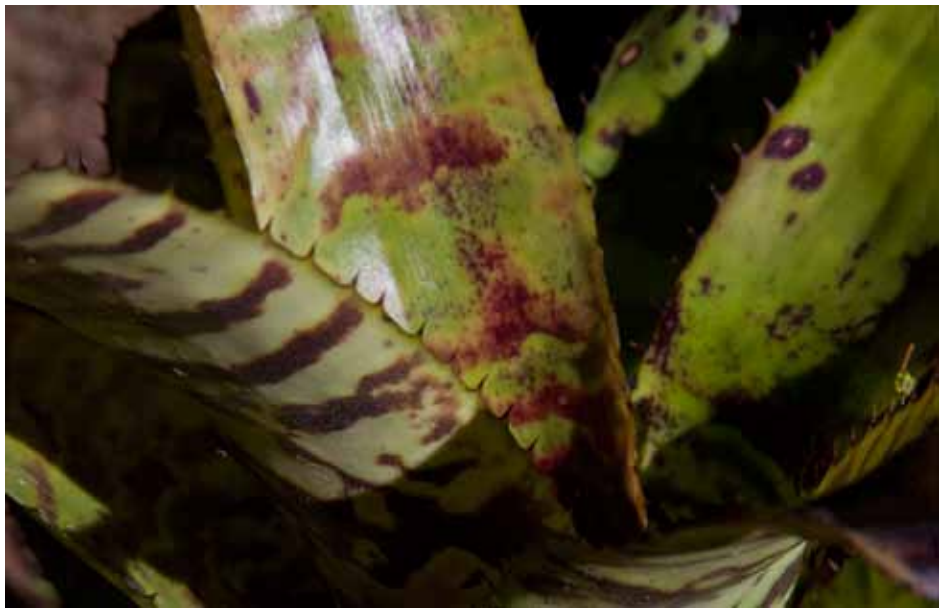
Zonation: zonata -Zoned; banded with distinct colors. Here the contrasting pigment bands runs across the leaf which when these bands line up with adjacent leaves gives the entire plant the look of a stunning series of circles.

coloir agro:

Intus - Inside - this references the inside surface of the leaf facing inwards - in Neoregelias it is the most visible aspect of the leaf, while in the tube forms like Billbergias and *Quesnelia marmorata* it is concealed by the tight form of the tight tube structure

Extrinsecus - outside - this is the surface of the leaf facing outwards - in Billbe-riags it is the most obvious leaf surface. In mature Neoregelias with spreading flat form, it is the leaf surface facing downward is less visible.

In some plants the pigmentation from Extrinsecus to Intus is partial or with a different pattern. In the leaf of this Achmea the pronounced pigmentation is on the underside of the leaf - Extrinsecus, while the pattern on the upper side - Intus is less pronounced.



Trichome patterns

All Bromeliads have trichiomes which are the tiny cells that are able to take moisture into the plant. While these might be invisible to the naked eye on some Bromeliads, others produce a profuse trichome pattern that not only becomes visible, but becomes a key aspect of the plant aesthetic and shows as a contrasting white silver. This is most often pronounced on the underside of the leaf, so in tall tubular forms like Billbergia the pattern becomes highly visible, where as with vase forms like Neoregelia the trichomes on the under side of the leaf surface and are less visible from above.

While the silver trichome cells are often dusted over the entire leaf surface, they can also form in bands that also add to the visual attraction of the plant. Trichomes on the leaves of Bromeliads vary a great deal. On some plants they can be arranged flat on the surface and be invisible to the naked eye, on other plants they can cover an entire leaf with an even pattern of long hair like cells. On some plants the trichomes are arranged in patterns, often strong bands across the leaf. However there are some plants like Alcantarea where a fined dusting of trichomes is present on the upper leaf surface. Of course Tillandsias have profuse trichomes coatings on both sides of the leaves and no pattern.

Billbergia 'Burle Marx'

Strong trichome banding on a Billbergia

Heavy dusting of trichomes on an Aechmea

Trichome banding on the upper surface of an Alcantarea leaf.

Spines colour and shape

Many Bromeliads have a series of spikes or spines that run along the leaf edge. These may be quite small insignificant or large and a feature of the plant. Sometimes the spines form only near the base of the leaf, while other plants form spines the entire leaf ending in a sharp spike at the leaf apeax or tip. Most often the spines are a contrasting colour (black or red) to the leaf and can offer another striking visual effect to the plant. The shape of these spines varies on different species, as does the height and spacing between them.

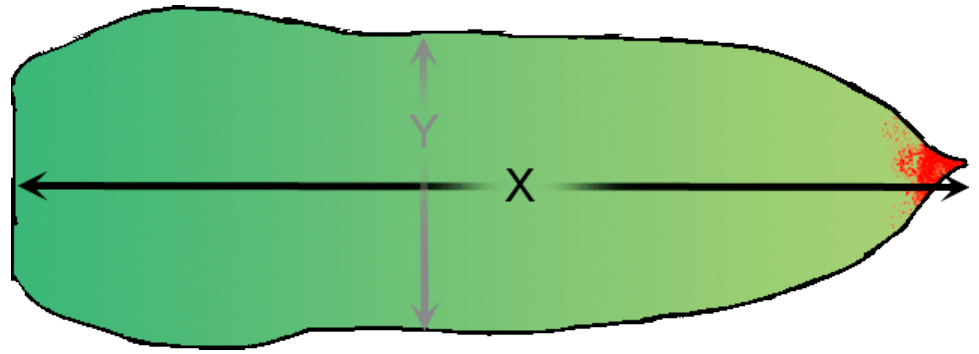
While, psychologically the visual appearance of spins on Bromeliad leaves can be threatening, suggesting danger, they can also offer an attractive element to the plant. The spines on many Bromeliad plants are small and relatively soft to touch, however there are other plants like Aechmea distichantha var distichantha that produce hard and sharp barbs and points on the end of the leaf that can inflict a nasty wound.

Leaf Shape

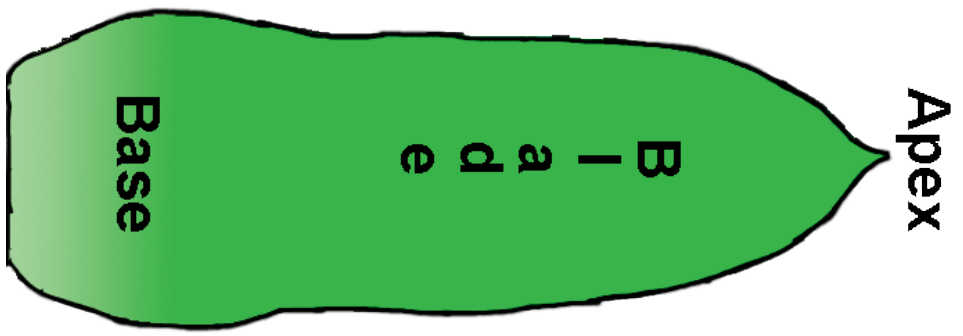
In aesthetics a closed shape is an important aspect and we can apply this to the leaves of Bromeliads.

The shape of Bromeliad leaves can vary greatly from species to species, but can also differ because of the aspect a plant is grown in. For instance many plants grown in full sun grow many shorter broader leaves while the same plant grown in a shady spot might develop less elongated thinner leaves, so drawing absolute comparisons can present an impossible challenge.

However, there are distinct differences between various species and hybrids. The leaves might range from needle-thin as in Acanthostachy strobilacea to broad as in Alcantarea regina. No matter where each of these plants are grown the leaves of one will never look like the other. While the length of the leaves of different species can contrast widely we can get a sense of leaf shape by applying an XY ratio. That is the length (X) of the leaf to the width (Y).



Most often the shape of the leaf varies down the length. The base might be distinctly different than the blade as the blade is to the apex.



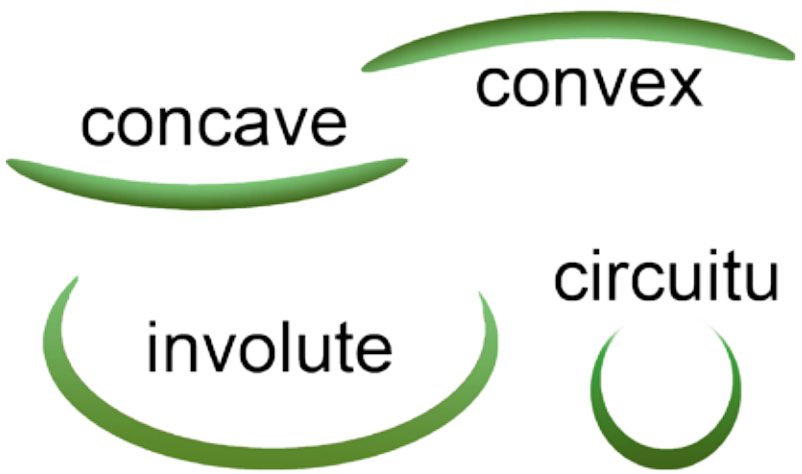
Leaves are most often symmetrical but some irregularity can occur particularly when the plant is subjected to stress like lack of water, or physical damage.

All Bromeliad leaves have some curvature In length, they can be nearly straight, curved. This curved form is designed to channel water into the center of the plant

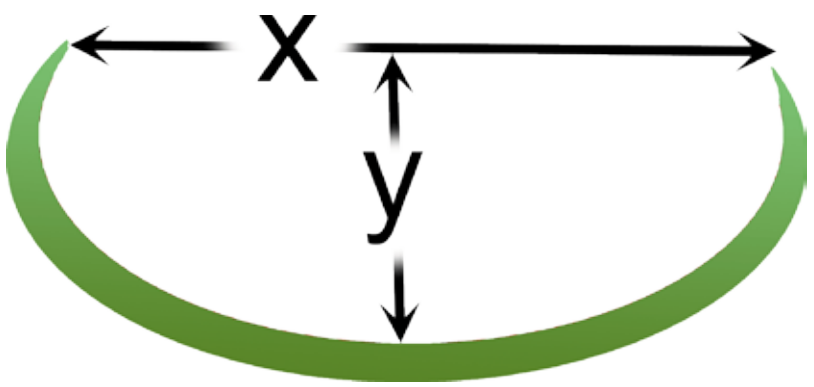
Leaf Cross-section

Aesthetically curving lines and arches are associated not only with gracefulness but strength and in many Bromeliads the repetitive arching leaves is an attractive feature. While in architecture the arches used for bridges, openings in buildings are elegant, they also offer great strength to these structures and this applies to the leaves of plants. So the cross sectional curve of a leaf affords extra strength in high winds, as does the longitudinal curve where the leaf often tapers to a point.

The cross-section of Bromeliad leaves have some curvature, there appears to be no plants with a hard fold or V shaped leaf. This curvature can be quite pronounced as Acanthostachy strobilacea where the form is almost circular (circuitu) or in some plants concave and much flatter. Some leaf edges can curve back towards the centre of the leaf. (involute). Again this curvature acts to collect water and channel it into the centre of the plant.



The degree of this curvature varies up the length of the leaf, but we can get a sense of the relative proportions by measuring the XY axis across the blade of the leaf.



Plant Form

This refers to the overall shape and form of the plant. Up right tube form as in most Billberbergias, spreading rosette,as in Neoregelias

First of all, notice that the scape is clearly labeled as the "stem" of the inflorescence. This is the bare stalk (although it may be brightly colored) that rises from the rosette of leaves that make up the bromeliad. In fact, Manzanares in Jewels of the Jungle Bromeliaceae of Ecuador defines scape as "a leafless peduncle arising from ground level (like a daffodil and tulip)" he further defines peduncle as "the stalk of an inflorescence". I like this definition because it's easy to visualize a daffodil or tulip bloom and then make the connection to scape. Part way up the scape at nodes where we might expect to see new leaves formed (if the plant were not in bloom) we now find scape bracts. Bracts are simply modified leaves and these specialized structures also may be brightly colored in some, but not all bromeliads. Many of the Billbergias for example have large bright pink or red scape bracts that catch your eye when the plant is in bloom. Continueing up the scape we next come to a second group of bracts known as the floral bracts. These are the structures at the base of each flower. Sometimes these floral bracts have a crease or 'keel' in the the middle which causes the inflorescence to be flattened in appearance. In some bromeliads the floral bracts may be so small as to be very inconspicuous while in other types they can be quite pronounced.

Looking now at the flower, the sepals are found between the floral bracts and the flower. There are three of these – one for each petal (remember that bromeliad flowers have three petals). Individually they are sepals. Taken together, they are called the calyx. Before we leave the petals - on the inside of each petal if you see a small overlapping piece of tissue, you are looking at a petal scale and that is the feature that distinguishes all members of the Genus Vriesea from any Tillandsia. Some Vriesas may look exactly like Tillandsias except for these petal scales, so you may need to look very closely to determine which Genus a plant should be included with.

Cayetano Ramirez's sculpture - "Fractal 3D1", 2007 cast with silicone from a Brassica plant resembles the impressive flower head of *Aechmea fasciata.*

Berries pods and capsules.

Many plants in the sub family Bromelioideae like Aechmea, Ananas, Billbergia, Neoregelia, Nidularium, Quesnelia, produce attractive berries or fruits which contain seed. In some of these plants like Neoregelia, Nidulariums, the seed berries are hidden deep within the crown of the inflorescence with only the tips showing and are only exposed when pulled from the crown when ripe. However in some plants the fruits or berries offer an attractive visual element that augments other visual elements of the plant like leaves and form. Of course, the most prominent of these fruits come from the genus Ananas, with the familiar pineapple, *Ananas comosus* producing the largest. While the pineapple is a delicious fruit to eat, at fruiting time, the large golden-yellow ovoid form with strong intersecting contour lines and complete with a mini plantlet at the top, becomes a focus point as it extends up through the crown of the foliage. While ornamental varieties like *Pineapple bracteatus* are smaller species, the leaves and fruit are even more stunning, streaked with yellow, green, red.

The berries of many Aechmea are highly visible as they ripen. After the plant has finished flowering the berries slowly begin to swell and change colour as they ripen, which can take 9 months or so. In some plants they turn from green to a dark blue purple black and the spiraling fractal arrangement of some plants are highly attractive. The berries of some Aechmea contain a sweet edible juicy contents with a dark purple pigment that can leave a stain on the skin.

Aechmea serrata, Aechmea nudicaulis , *Aechmea calyculata*, Aechmea 'Covata'

Aech ornata var

http://en.wikipedia.org/wiki/Genetic_diversity 30/5/2015

Photographic Bromeliads

Digital photography has made the task of photographing Bromeliads so much easier than the days of analogous systems and film. Of course, the huge advantage is that once the photograph has been taken the image can be reviewed, if the exposure is not correct a quick adjustment of a range of controls and a "correct exposure" can be obtained in seconds. In fact many devices allow the operator to see the image before they take it. While it is possible to take great photos with mobile phones, I Pads and small compact cameras, there is no doubt that a more sophisticated camera in the right hands will produce superior results.

The number of photographers who purchase sophisticated equipment then rely on using an automatic setting for all their exposures is staggering. There are many reasons why they never get to utilize the full potential of their equipment, but in my experience it relates to not having the time, having no confidence to work out a method of experimenting, and the complicated manner camera manuals present technical information about how the camera works. In all it becomes a mine field most people do not want to enter.

Gaining an accurate photograph of a Bromeliad poses many problems that can never be solved in a few quick steps, however the following is a guide that suggests a general pathway. It assumes that a camera with a good range of modes and settings is used. A camera like an SLR where the ISO, exposure mode, shutter, aperture etc. can be set independently.

Taking photographs that accurately records a plant is a science that volumes have been written about and some professional photographers agonise over these issues for their entire career.

The problem is there are so many variables. For instance;

- the quality of the light in terms of white balance - if the light has a blue or warm cast when the photograph is taken all the colours will have this cast. Photographing Bromeliads at shows and exhibitions this will effect the colours

- exposure - if the photograph is under exposed all the colours will have a darker cast, while if the photograph is over exposed the colours will be lightened.
- the type of file the image is saved as - Raw files save all the recorded information while a jpg compresses the information.
- the individual camera can even have an effect.
- setting colour profiles of a screen and printer

So it is easy to see that without offering a full colour photo management course it is not possible to nail this down completely.

Some photo basics without too much jargon

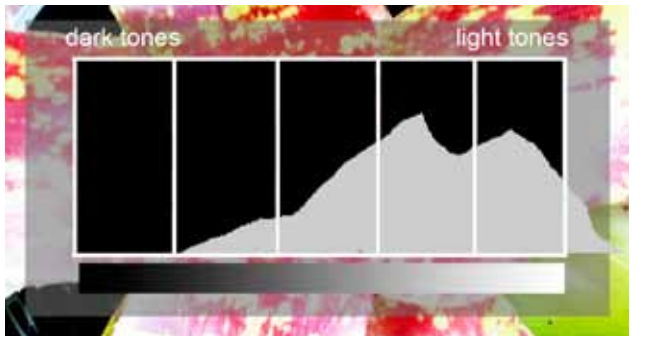
Migapixels: All digital cameras have a sensor that records that amount of light energy entering the lens from various parts of the subject. The sensor is actually made up of millions of microscopic sensors and each one is like a solar panel that records the exact amount of light falling on that area. Theoretically, the more megapixels, the more information a camera can record. So a 24 mp camera can record more detail than a 12mp camera. Each sensor records red, green, blue areas of the scene, so when the file from a 24 mp camera is saved as a raw file, the file size is 3 x 24 or 72mp. While your camera might be capable of recording 18 mp, the default menu setting with some cameras can be less than this. To gain the maximum result, the setting may need to be altered, so check the file size resolution in your cameras menu. I have witnessed proud photographers who delight in owning a 24 mp camera but never realize that for years they have had the file setting on 12 mp. The larger file sizes are great for recording detail and high quality images of Bromeliads for publication, but if you want to email an image or paste it on FaceBook etc. then you will need an app that allows you to reduce the file size.

File type and size: When a digital photograph is taken, the light falling on each pixel is recorded as a series of numbers which can be interpreted as an image. This can saved in its entirety by setting the file type to RAW. Some cameras also allow the file to be saved as a TIFF. Both RAW and TIFF formats do not compress the data and offer access to the greatest amount of detail. However the data is unprocessed and the image may look unsaturated and flat. These file types rely on the photographer having access to an application like lightroom, photoshop or the camera manufacturers software and the skill to engage in post production techniques that will enhance the image to its fullest potential. It is worth remembering that when shooting in raw, any image that is viewed on the LCD screen is converted to a JPG and is processed by the camera. So the image on the camera screen can look vibrant but when opened on a computer screen loose its punch. While a RAW file can be opened and various levels, like exposure, saturation etc. set via a RAW file converter, the file has to be saved as a separate file, say Psd (photshop), Tif, Jpg to bee accessed by other applications. However, while the RAW can be saved and retain the new level settings, the file retains all of the original information which can be retrieved at any point.

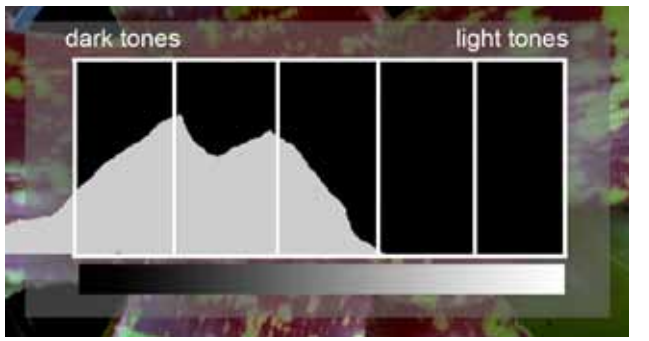
The other file setting offered is JPG, which compresses the information to save space on the card and allow more images to be recorded. When saving as JPG the processor in the camera alters the information to produce a more "acceptable" image based on the processor sequencing in the camera, the information lost in processing is irretrievable. While JPGs are great if you do not want to get involved with processing the photograph, they reduce the quality and potential. Many camera default setting is for JPGs, so again check the menu.

Correct exposure: Correct exposure is a combination of allowing the right amount of light to fall on the sensor for the correct length of time to create an optimum exposure where the colour an tone of the original scene is recorded faithfully. If there is not enough exposure (under exposure) the resulting image will look too dark, and correspondingly if the exposure is too much (over exposure) the image will look too light and washed out. While most people using a digital camera are happy with an image where the exposure looks "OK", there are ways to optimise the exposure so it records the scene with greater accuracy.

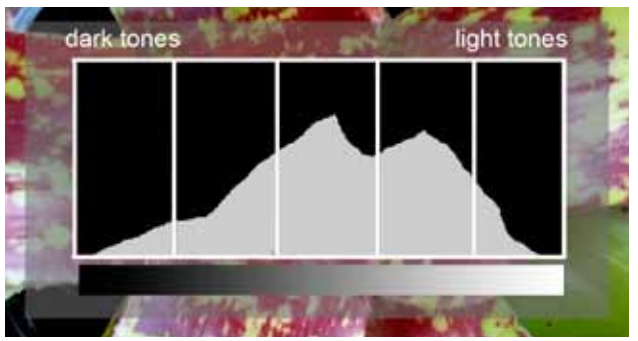
Histogram: One of the great advances of digital cameras has been the inclusion of a histogram into the processor, which is basically a graph that allows the tones within the image to be viewed in a manner that gives accurate information about the exposure. This feature can be turned on or off through the menu.



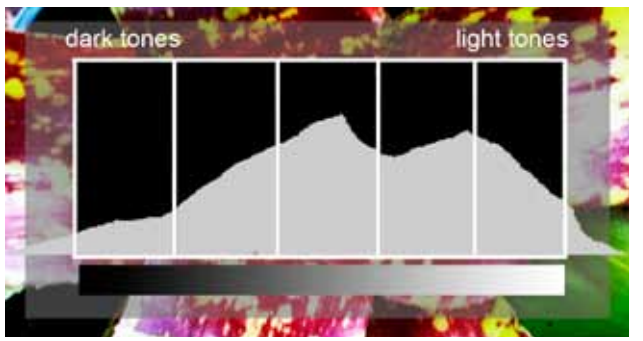
In this illustration the grey curves have shifted to the right and outside the boundaries of the histogra, which indicates that the image is over exposed and areas of lighter tones have not been recorded.



In this illustration the grey curves have shifted to the left and outside the boundaries of the histogra, which indicates that the image is over under exposed and areas of darker tones have not been recorded.



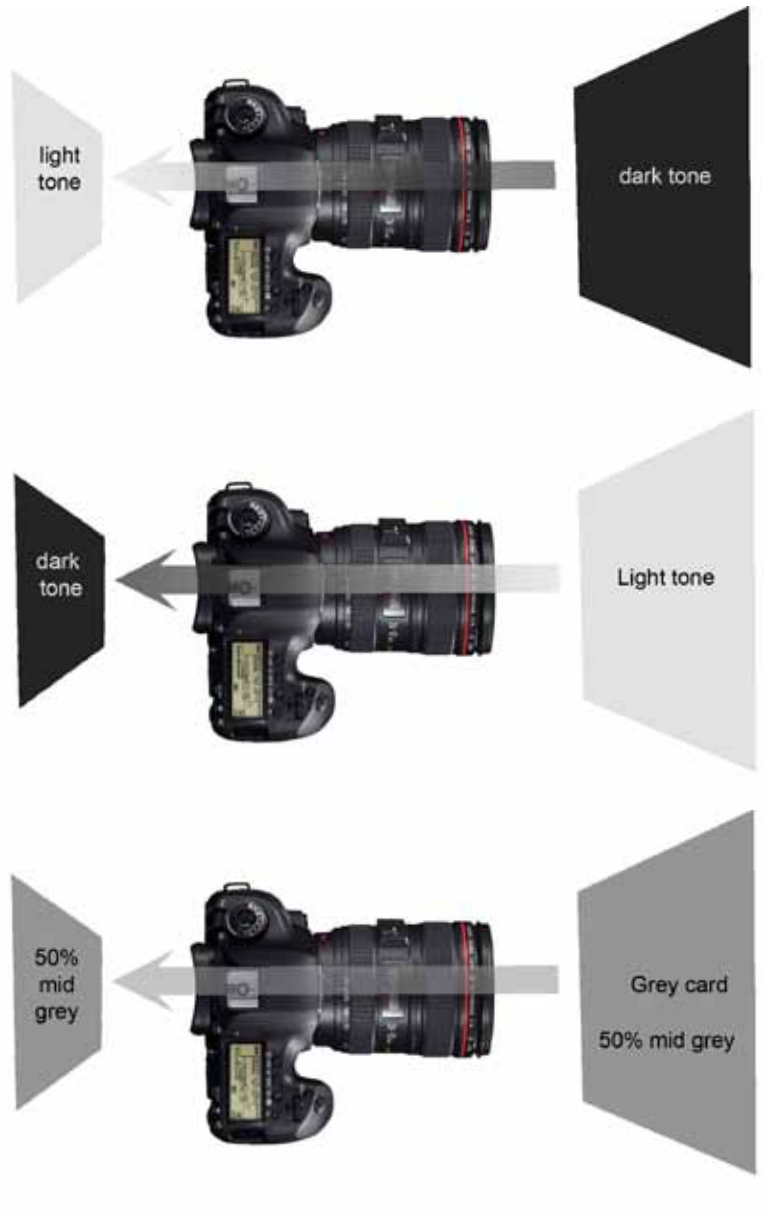
In this illustration the grey curves which represent the tones of the image,fit within the boundaries of the histogram or exposure latitude of the sensor, which suggests a correct exposure.



In this illustration the grey curves extends outside both ends of the histogram, which indicates that the tonal range of the subject is beyond the recording capacity of the sensor.

However just because the curve falls within the histogram parameters does not mean the exposure is precise. When the camera light meter takes a reading from a scene it averages out all the colours and tones to produce a mid gre

If the scene has predominately dark tones it will take a reading that records the subject lighter.



like wise if the scene is very light, the metering system will average it to record the subject elements darker.

Grey card: One means of gaining a correct exposure is a grey card. This is a tonal reference card that professional photographers might use. The card is precisely coloured mid grey (50% grey). If a reading is taken from the card then the exposure made of the scene the tonal values will be more precise.

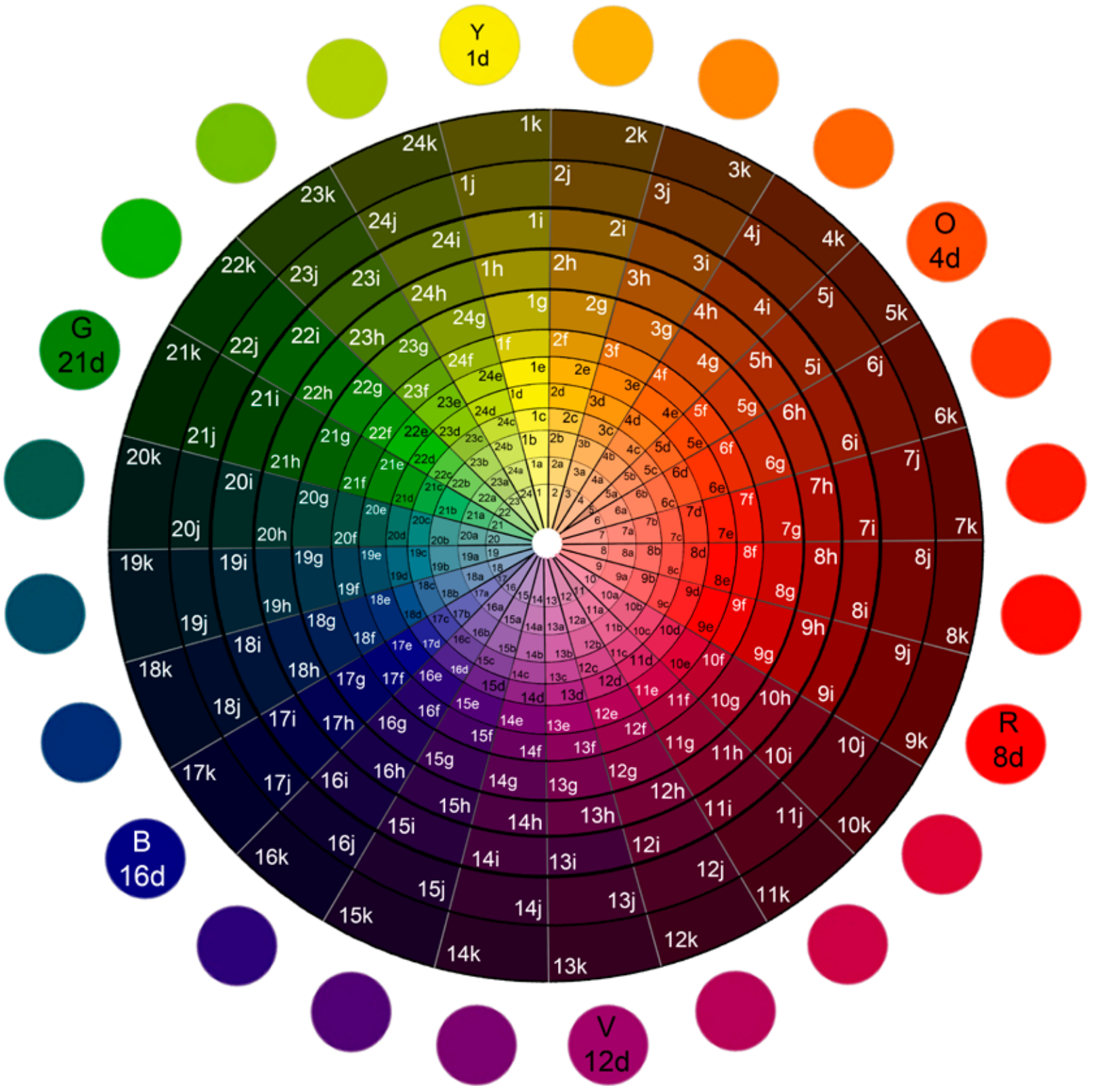
There are various types of grey cards available commercially, but they all work in a similar fashion.

White balance: When a digital photograph is taken, the camera has a system of balancing the colour of the resulting image to the ambient colour of the light falling on the scene. Many photographers are completely unaware of this with the default setting on auto and accept the results. While this works OK for many subjects where the camera can ascertain a "white" there are situations where the colour goes noticeably astray. However in the menu is the facility to set the while balance more precisely for sun, tungsten, fluorescent etc. While the colour can be adjusted in Photoshop or similar applications, the best option is to shoot in RAW which allows the colour temperature (white balance) to be adjusted precisely. However matching both exposure and colour can be managed in a precise way by using a colour chart such as XRITE Color Checker or similar device.

This is a small chart of predetermined colours and tones. While using this can get involved, at the simplest level it allows the photographer to include it in a photograph they are taking (or take two photos - one with the chart one without). The predetermined colour can then be checked through light room or photoshop and the colour matched exactly.

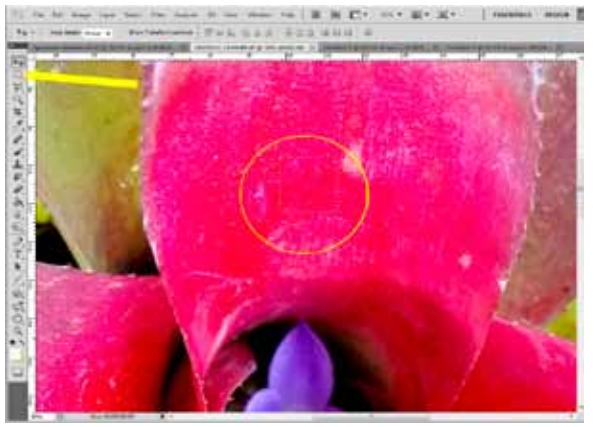
What significance does all this have for photographing Bromeliads you might ask.

Establishing accurate colour of the pigments within a plant via a photograph allows the colour spectrum chart to be used to accurately ascertain a colour within the leaf through a numerical system. For instance a plant could be said to have leaf colour where the greens range from 22e to 21b while the red pigments range from 4h to 5d.

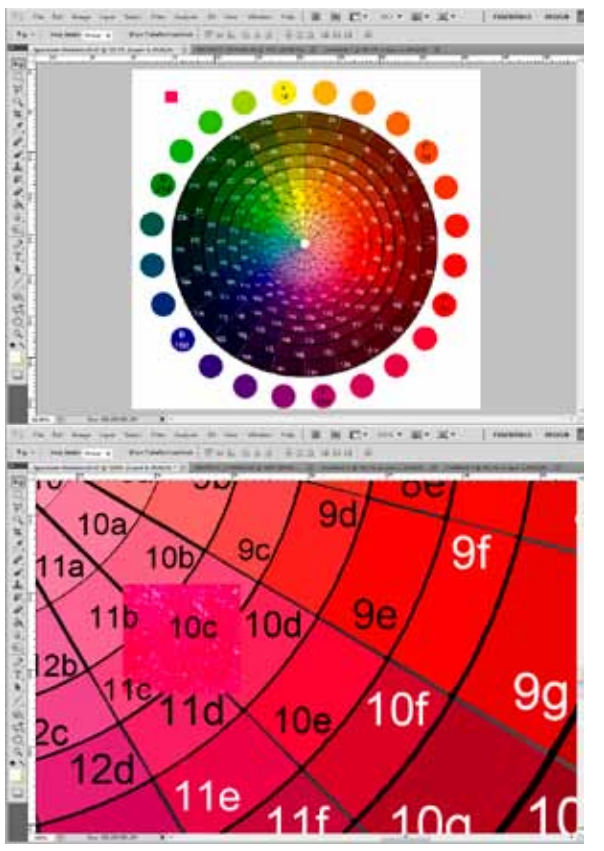


Down load a high resolution digital file of this colour chart to match your Bromeliad pigments against

The first step in matching a section of colour on a plants leaf via photoshop to the colour wheel, is to select the section of pigment in a photograph using the rectangular marquee tool (located at the top of the tool bar where the yellow arrow points to in the illustration) . Move the cursor to the desired area on the photograph and draw out the rectangle to select a small area of colour, then copy this area (Ctrl-C) or at the top tool bar Edit > Copy. In the illustration this is marked with the yellow circle.



Open the colour wheel in photoshop and paste (Ctrl V) or Edit paste the section into the wheel. The small area will be pasted as a separate layer from the colour wheel which will allow it to be moved anywhere on top of the image of the wheel. In the illustration it sits at the top left as a small square.



Using the move tool (short cut V) at the very top of the tool bar, shift the pasted square around the chart until the colour matches the colour below in the wheel.

While this can be done by eye, a more precise check can be obtained by opening the information panel, (from the top bar Window > Info), then using the eye dropper tool (short cut I) to move over the appropriate area which read the colour by showing RGB numbers. When these 2 match as close as possible this is the pigment colour. In the illustration this would be 11d. Note that the area measured by the dropper can be varied once it is selected at the top under "sample size".

While not perfect, this system acts as a constant colour guide where the colour on a leaf or flower can be matched to a number code. It also allows one to see what colours a particular plant produces and where these sit in relationship to each other.