BROMELIANA

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OUR SPRING PLANT ORDER

by Herb Plever

It seems incongruous that I'm looking out the window watching 3 inches of snow falling, while composing an article for our Spring plant order. This incongruity seems of a piece with a cold, snowy winter and the fact that 2012 was the hottest year in 4,000 years. What seems to be a contradiction is part of a natural dialectic, and it is patently and scientifically clear that global warming and climate crises will be impinging on our life styles with increasing severity.

Aechmea nudicaulis v. aequalis
photo by Paul Wingert

So to cheer you up, we have our annual spring order in April. At the next meeting you will see pictures of the plants on the order in bloom. I have cut down the list to make it easier for you to choose.

Among the Aechmeas I have added *A.* 'Mend', the rose marginated cultivar of *A. lueddemanniana* for those who were attracted to Cynthia's plant shown in the March issue. Don't order this plant unless you can give it good light and the space for a spreading plant. There are also some small Aechmeas such as *A.* 'Sueños', *A. nudicaulis var. aequalis* and the red form of *A. recurvata*.

These are followed by some different, exotic, small beauties: Hummel's dwarf *Billbergia* 'Fantasia', *x Billmea* 'Casper' (*Billbergia decora x Aechmea recurvata)* and *x Billmea* 'Rosebud' (*Billbergia pyramidalis x Aechmea recurvata).*

There are eight really lovely Cryptanthus, all either barred and marked or intensely pink. 4 of which we haven't seen before: 'Absolute Zero', Evon', 'Fever Frost' and 'Unabashed', all by the talented hybridizer Jim Irvin.

Held over from last year is are the very pink 'Ruby Star' and 'Arlety' that caused members to ooh and aah when they saw delivered at the May meeting. By special request we are repeating *Cryptanthus fosterianus* and *C.* 'Strawberries Flambe'. All these Crypts are dramatic and beautifully marked; you should add a few to your collection.

I will not put the very spiny *Deuterocohnia mezziana* on the list again until mine flowers so members can see its huge, branched spray of yellow flowers on a tall scape. My plant is growing well and is close to blooming size. By special request *Dyckia fosteriana* cv. 'Silver Queen' and *D.* 'Big Black' are on the list.

Your very large order of mini Guzmanias (and Vrieseas) has already been processed, and in addition we have two favorites: variegated *Guzmania* 'Anita'

NEXT MEETING - Tuesday, April 2nd , 2013 promptly at 7:00 P.M. at the Ripley-Grier Studios 520 8th Ave. (between 36th & 37th St) Room 17A

VIDEO OF PLANT ORDER - Photos of the bromels on the spring order including many closeups of their inflorescences to help you make your choices. Take advantage of this chance to buy great plants at bargain prices, delivered to you in May. Please bring in plants for sale and for Show and Tell.

x Billmea 'Casper' ph. M. Kiehl from BCR

Cryptanthus 'Evon' ph J. Irvin from BCR

Neoregelia 'Andromeda' ph Irvin BCR

and the purple blooming *G.* 'Amaranth'. All of the 8 Neoregelias are tiny to small plants that can fit on a window sill. They are all new to us (except for *N. lilliputiana),* beautifully colored and marked; you'll find them hard to resist buying: *Neoregelias* 'Andromeda'(Jim Irvin), 'Aurora'(G. Hendrix), 'Bam' (Chester Skotak), 'Blushing Tiger' (Lisa Vinzant), 'Ed Prince' (Chester Skotak), 'Multicolor' (K. Williams) and 'Palmares' (Chester Skotak). (Chester is not only the most prolific bromeliad hybridizer on record, his output is almost always of the highest quality and uniquely creative. His work with Alcantareas, Ananas, Guzmanias, Neoregelias, etc. is simply amazing and unparalleled.)

Also on the list per your requests are *Orthophytum gurkenii* and *O. magalhaesii* at a much lower prices than before. We have our usual long list of Tillandsias still at decent prices, and 5 very nice Vrieseas including *Vriesea* 'Sunset' that was shown in Cynthia's March article. However, I continue to lament that so many Tillandsias are still not available anywhere: *Tillandsias dyeriana, grazielae, laxissima, mauryana,matudae,oaxacana, sucrei, turquinensis* as is the once common *Vriesea splendens* (at least they are not available in the U.S.). I have now found and included *T. attroviridipetala* and *T. plumosa.* ❑

PHOTOSYNTHESIS Part 2

by Don Beard

(Excerpted from Far North County Bromeliad Study Group, New South Wales, Aust. Newsletter, April 2012)

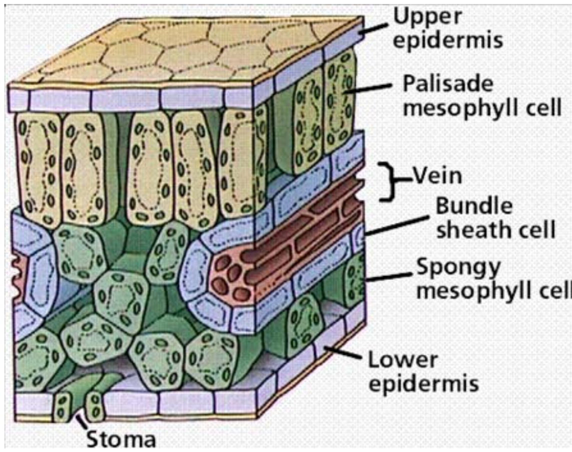
...recall that the equation for photosynthesis, simply expressed, is: $6CO_2 + 6H_2O$ --SUN - Chlorophyll = $C_6H_{12}O_6 + 6O_2$

However one additional item needs to be introduced with respect to C3 plants, and that is the enzyme/catalyst RuBisCo. This is probably the most abundant protein on earth and is used to fix or trap carbon dioxide (CO_2) in the process of photosynthesis. In a C3 plant where the first product of photosynthesis is a molecule with three Carbon © atoms, RuBisCo acts alone.

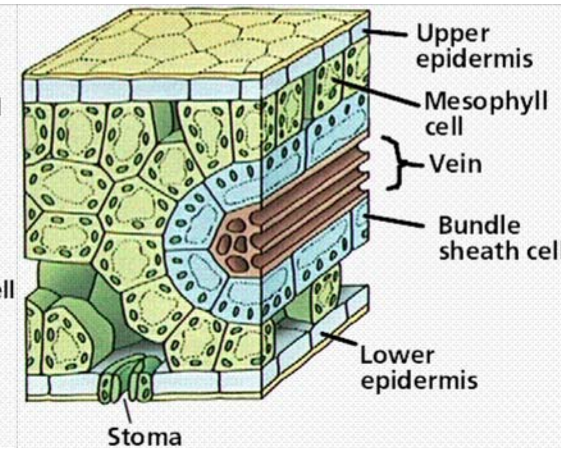
Slightly up the evolutionary ladder are plants where the first product of the photosynthetic process is a molecule with four C atoms and where RuBisCo does not act alone. These are C4 plants and were developed along a number of parallel evolutionary lines in order to tolerate aridity, high temperatures and low CO_2. These C4 plants developed by some five to 10 million year s ago, late in the Miocene. This was also during a maximum glacial period. These plants were all phylogenetically derived from C3 plants. Examples of C4 plants include grasses, maize, corn, sugarcane, sorghum and lots of weeds.

Leaf Anatomy

There are anatomical differences between the leaves of C3 plants and C4 plants. Note the differences between the two drawings on the following page. With regard to the vein or vascular bundle, the C4 leaf has a vein that is surrounded by thick walled parenchyma cells which are more tightly packed than for the C3 leaf. These are the bundle sheath cells (BSC) and in a C4 plant it is where the photosynthesis takes place (see photo p13). The much less tightly packed arrangement for the C3 leaf is what eventually allows CO_2 to escape back into the atmosphere i.e. the process of photorespiration. This process is negligible to absent in the C4 leaf. C4 plants generally exhibit parallel venation and have more veins per unit area.



Crossection of C3 Leaf



Crossection of C4 Leaf

(Editors Note - Most Bromeliads use Crassulacean Acid metabolism - **CAM** to fix carbon dioxide. All of the *Pitcairnioideae* (ie. *Brocchinia, Cottendorfia, Fosterella, Navia, Pitcairnia, Puya)* except *Dyckia* use the **C3** pathway. In *Tillandsioideae, Catopsis* and *Vriese*a and only a few species of *Tillandsia* and *Guzmania* use **C3**. The rest of *Tillandsia* and *Guzmania* and all the genera of *Bromelioideae* such as *Aechmea, Billbergia* etc. are **CAM** plants.)

<u>The C4 Mechanism</u>

Whereas the RuBisCo in the C3 plant fixes the CO2 (rather poorly) and prepares for the photosynthesis process in all the chloroplasts in all the mesophyll cells, the C4 plant has a more efficient way of fixing the CO2.It has a much more efficient enzyme called PEP which compared to RuBisCo has a much greater affinity with CO2. When the stomata open in the morning, the PEP combines with the incoming CO2 and forms oxaloacetic acid and then malic acid. Both these compounds have four carbon atoms in their makeup...hence the C4 pathway or C4 plant. The malate then travels to the bundle sheath cells (BSC) where it is converted back to CO2 and PEP. The CO2 is then fixed by the RuBisCo in the bundle sheath cells, and photosynthesis occurs with its resultant sugar via the C3 pathway and the Calvin cycle. (In bundle sheath cells CO2 + PEP CO2 + PEP oxaloacetic acid malic acid RuBisCo - Calvin cycle - Sugar)

The combined efficiency of PEP in fixing CO2, together with the tightly packed double ring of bundle sheath cells and mesophyll cells (called Kranz anatomy..... meaning 'wreath'), makes for an easy method of concentrating CO2 without allowing it to escape. An efficient sugar making process. A marked contrast to the C3 plant. An additional feature of the C4 plant is its ability to close it's stomata in the heat of the day. This of course prevents loss of water. So with low transpiration, negligible photorespiration, and efficient sugar making we have evolved our drought, heat and low CO2 tolerant plant. Note that photorespiration which is in general caused by the uptake of O2 (oxygen) instead of CO2 by the RuBisCo enzyme, undoes the good work of photosynthesis in the C3 plant. From the increased light use efficiency of the C4 plant we improve the quantum yield or in other words growth of the plant. As a consequence of this, many C4 plants are grown commercially and are recognized as some of the world's major crops.

<u>C4</u> Plants: Occurrence and History

As stated before C4 plants include many grasses and sedges, many weeds including crabgrass and nutgrass. Also corn, sorghum, millet, sugarcane, and salt bush.C4 plants make up 4% of the worlds plant biomass, 15% of all plant species, and 20% of plant commercial production. C4 plants are common as monocots (one seed leaf), 50%, and uncommon as dicots (two seed leaves), 0.6%. Some plants are intermediate between C3 and C4 pathways, i.e. C3 plants exhibiting C4 traits. Some young plants can switch from C3 to C4, some C3 plants have C4 characteristics in their roots, stems, and petioles. Obviously one is not drawing too long a bow to think only minor adjustment was needed for a C3 plant to evolve into a C4 plant.

Recent earth history describes a decreasing CO2 level. During the Cretaceous (some 130 million years ago) CO2 was at a level four to five times that of today. This level seriously decreased in the late Oligocene (25-30 million years ago) and continued decreasing to the end of the Miocene (5-10 million years ago) to about 400ppm (parts per million), a little more than today's level. Under these conditions C4 photosynthesis has developed a number of times in a number of plant lines in the 25-30 million years since the late Oligocene, getting to today's numbers by the end of the Miocene. Assuming that low CO_2 is a pre-condition for the development of C4 plants, parameters such as increasing aridity, high light habitats, increasing temperature and seasonality, fire, and the distribution of grazing animals, are all thought to play an important part in this evolutionary trend.

At temperatures $22^{\circ}C$-$30^{\circ}C$, Quantum yields for C3 and C4 plants are the same Temperatures above $30^{\circ}C$, Quantum yields greater in C4 plants Temperatures below $22^{\circ}C$, Quantum yields greater in C3 plants.

C4 Plants	**V.**	**C3 Plants**
* Can shut stomata in heat of day		* Can't
* First product has 4 C atoms		* First product has 3 C atoms
* PEP and RuBisCo		* RuBisCo only
* Tight gas barrier about BSC		* No barrier
* BSC have chloroplasts		* BSC have no chloroplasts
* Venation... parallel and closer.		* Venation… anything
* PEP loves CO_2 and wont take up O_2		* RuBisCo can't tell difference between CO_2 and O_2
* Photosynthesis restricted to BSC chloroplasts		* Photosynthesis operates in all mesophyll chloroplasts
* No photorespiration		* Up to 30% photorespiration
* Can utilize low CO_2		* Needs high CO_2
* High rates of photosynthesis and growth particularly in tropics. Drought tolerant.		* Lower rates of photosynthesis .Can't handle arid situations and high temperatures
* Dominate open hot arid environments.		* Low water usage efficiency.

Alloteropsis semialata – transverse section of C4 leaf showing veins and BSC. Cockatoo grass, occurs in northern Australia. (From Watson, L., and Dallwitz, M.J. 1992 onwards. The families of flowering plants: descriptions, illustrations, identification, and information retrieval. Version: 18th May 2012. http://delta-intkey.com)

On a final note, rice is a C3 plant. Science has for some years been striving to develop it into a C4 plant. Imagine what that might do for rice production and the world's food problems.

References: As with Photosynthesis 1, this presentation was gleaned from the following scientific articles and internet pages: Sage et al, 2011, The C4 plant lineages of planet Earth. J. Exp. Bot.; Sage 2004, The evolution of C4 photosyn-thesis. New Phytol. 161: 341-370;en.wikipedia.org/wiki/**C4**_carbon_fixation;http://www.marietta.edu/~spilatrs/biol103/photolab/c4photo.html;http://creation.com/c4-photosynthesisevolution-or-design;http://

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