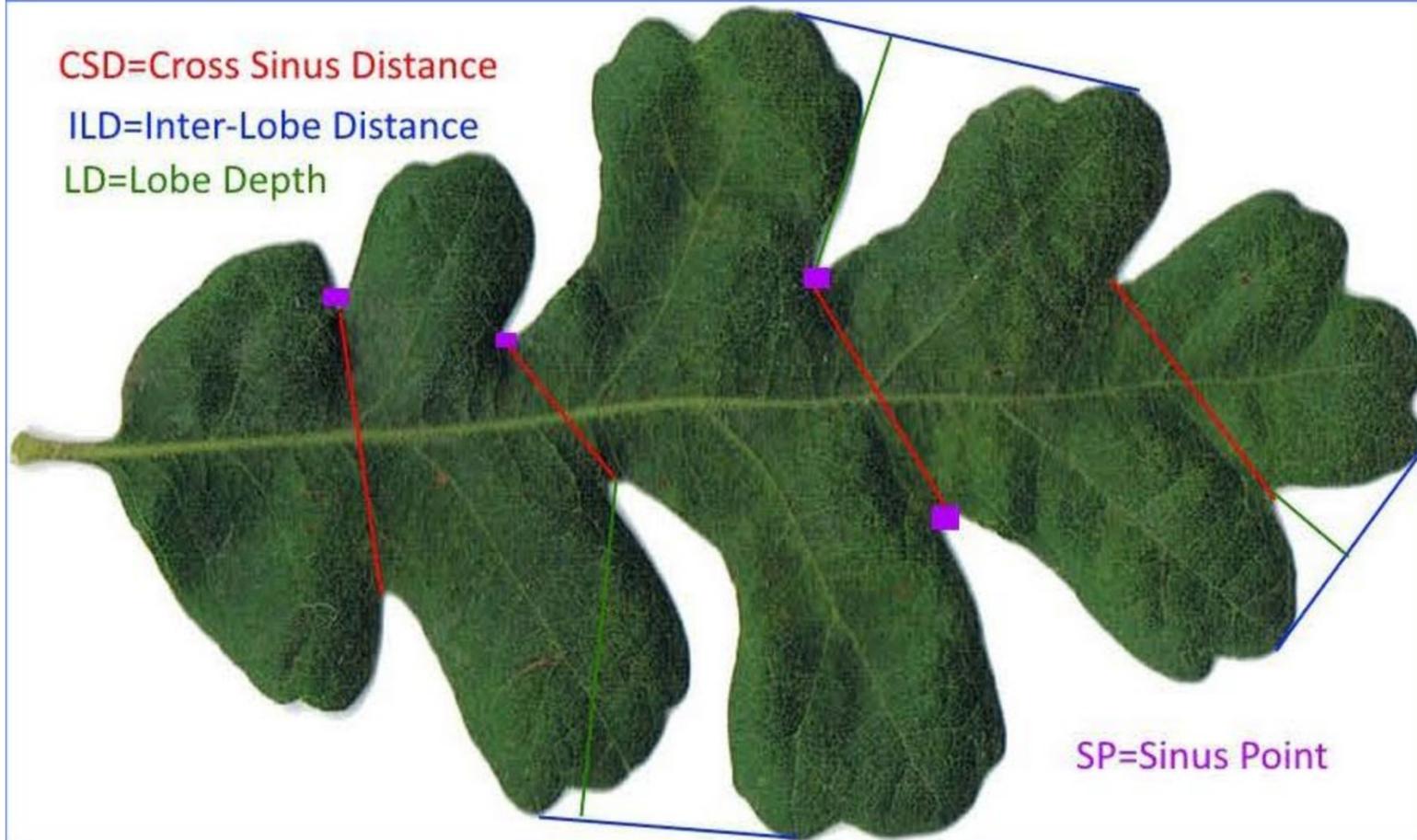


TAXONOMY OF ORNAMENTAL PLANTS

NEW TECHNOLOGIES, TECHNIQUES, AND INSIGHTS
ON THE IDENTIFICATION, CLASSIFICATION, AND
NOMENCLATURE OF LANDSCAPE AND OTHER
ORNAMENTAL PLANTS



BY
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TOOP=Taxonomy Of Ornamental Plants

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The first available public version will be offered from www.cultivar.org at no cost beginning in January 2020 but a subscription program will be available for updated, larger versions of the work that are produced over time.

It will never be finished. Never. Well maybe it might be done when I'm accessioned with a granite label in plot 99-SD of a peaceful arboretum-like place. In the next thirty years or so (Our Dear Lord willing) I am adding to this website/ebook as often as my hortobotanical muse that looks a lot like Liberty Hyde Bailey whispers. I'm a frightfully weak, lazy, and inept imitation of LHB (though a bit smarter from trolling his Cornell Pinetum and vouchers) so he needs to shout now and again. All this will be hopefully with some corrections and additions by the readers over the coming years. My biometric studies of cultivars continue with new data and analyses coming. Websites and ebooks cost nothing but time and effort to update so let's take advantage of that. This work is a spin-off and ultimate maturation of **T-LAN (Taxonomy of Landscape Plants)** I wrote and curated as a website from 1999 onward but this is more academic and detailed in focus with lots more plates and examples. That had a good following and many reader additions and comments. Much of it was eventually put into Hatch's Perennials and Cultivars of Woody Plants for reference there under individual taxa. In fact, **Cultivar.org** as we see it today was originally prototyped under the code name TLAN2.

If you find anything useful please use the following type of **citation**:

Hatch, L.C. [publication year]. Taxonomy of Ornamental Plants. Cultivar.org publisher, Cary, North Carolina, Version Date, [link to page] or <http://cultivar.org>

While on the topic of literature citations I have gone with the **Harvard format** provided by Google Scholar in most references below. Links are sometimes put in a small font to avoid the page being 20 inches wide and therefore hard to read in any known format. In a few cases you will see [Link Reduced](#) because the URL could not be sized to a readable, small font.

Types of taxonomists: a million specialities. Let's talk about taxonomy in general and present a broader hierarchy of what it means to be a taxonomist in modern times. It took me decades to figure out who was whom and the various roles in both biological and non-biological fields. Your comments and suggestions are welcome as this is not a clear cut or universally accepted set of divisions.

- **Taxonomist** - a person who classifies, groups, organizes, measures, establishes relationships among units, determines origins, and names a specific, defined collection of objects or entities.
 - **Biological taxonomist (systematist, taxonomer)** - one who works with living organisms or biological species. Within most of the following disciplines there are experts who emphasize classification with chemistry (chemistry), morphology/biometrics, and DNA.
 - **Insect taxonomist (entotaxonomist)** - those working with insects. They often specialize in groups such as arachnids, beetles, flies,

centipedes, butterflies/moths, and such.

- **Fungal taxonomist** - those working with fungal species
- **Ornithological taxonomist** - those working exclusively with birds.
- **Plant taxonomist (phytotaxonomist)** - dealing only in the Plant Kingdom
 - **Botanical taxonomist** - dealing with native, non-cultivated taxa, that is wild plants or occasionally naturalized ones that have escaped. There are many specialists from the family to the subgenus levels. Legume taxonomists and orchid taxonomists are obvious and some never work outside those groups their entire careers. Their approaches range from traditional morphology (**phytomorphologist, biometrician**) to embryology (**phytoembryologist**) to cells (**cytologist, cytogenecist**) to elaborate DNA sequencing (**phytogeneticist**) and sometimes combinations of several techniques.
 - **Poison plant taxonomist** - this is a very important role for herbaria and botanists in general. The very life of humans and animals, all precious and valuable, may come down to analyzing a leaf fragment taking from stomach samples. Do the doctors or vets treat this way or another? The identification of toxic plants is a major and very crucial field.
 - **Paleobotanical taxonomist** - working with prehistoric, usually extinct species of plants in genera that are current and sometimes lost forever. A general **paleotaxonomist** or **paleobiologist** may also deal with animals and microbes.
 - **Nomenclaturist** - one dealing mainly with names and naming convention, selecting the best nomenclature and publishing it in Latin if necessary. Mastering the nomenclature codes, both botanical and cultivated, are practically a law degree in themselves.
 - **Dendrological taxonomist (forest taxonomist)** - one working exclusively in woody plants with an emphasis on forest species such as pines, spruce, fir, both cultivated and native taxa. These professionals typically work in the forestry field and not horticulture or plant science. Some experts consider all **dendrology** to have a taxonomic emphasis while to others it's a much broader field. Some people consider forestry to be part of agriculture and by some definitions it would be. Historically they are different departments or even colleges at many universities and while they learn from the other, the experts do not always mix.
 - **Agricultural plant taxonomist** - dealing with cultivated plant taxa of interest to agricultural fields.
 - **Agronomic taxonomist** - dealing with field crops such as corn, wheat, barley, etc. They are often also **phytogeneticists** and **plant breeders** because they have come to classify corn, for example, in terms of cytology and specific genes. The taxonomy, genetics, and breeding of field crops is much more unified in one job or role than in many other agricultural fields but things are a'changin in this direction.
 - **Horticultural taxonomist** - one who works with garden and non-agronomic crops.
 - **Cultivar historian** - this is a term I came up for my email signature and it about sums up what I do in terms of studying and documenting the origins, names, descriptions, identification, and botanical classification (species affinity, hybrid parentage, variety, subspecies, forma) of cultivated varieties. It can fit under any of the following categories but sometimes spans different groups. I have been known to help out students finding the origins and true details of a fruit or vegetable cultivar too. Not all taxonomists deal in history so this is a definately a subspecialty.
 - **Pomological taxonomist (systematic pomologist)** - dealing with cultivated fruit taxa including tree, cane, and herbaceous species such as apples, blueberries, raspberries, and strawberries
 - **Viticultural taxonomist** - one dealing exclusively with grape varieties of the genus Vitis
 - **Ornamentals taxonomist** - one dealing with plants having showy or decorative fruit, flowers, or foliage including landscape plants and floricultural crops. Besides the specialities noted below some get very narrow with specific interested limited mainly to Rosa, Hosta, Iris, Gesneriads, Begonia, Camellia, and Narcissus. We count on these specialized taxonomist to

register cultivars with detail, create Cultivar Groups, and classification systems that useful for both taxonomy and flower shows.

- **Floricultural taxonomist**
- **House plant taxonomist**
- **Ornamental coniferological taxonomist**
- **Ornamental dendrotaxonomist**
- **Ornamental Geophyte taxonomist**
- **Herbaceous Perennial taxonomist**
- **Ornamental Cactus and Succulent taxonomist**

▪ **Olericultural taxonomist** - one working with vegetable crops, residential and commercial, such as potatoes, lettuce, cabbage, beans, cucumbers, etc. There may be some overlap with the agronomic taxonomist in terms of species like corn, but generally here these are considered edible taxa for humans as opposed to agronomy with covers species edible to both humans and livestock.

▪ **Animal taxonomist** - working in the Animal Kingdom

- **Zoological taxonomist (zootaxonomist)** - dealing with wild, non-domesticated taxa. They often specialize in various classes and orders such as mammals, carnivores, whales, fish, horses, canines, rodents, felines, reptiles, amphibians, etc. Even if one is simply a seashell collector, the taxonomy there gets pretty complex and important very quickly as your collection grows.
- **Animal science taxonomist** - dealing with domesticated, agricultural, or industrialized animal taxa such as cattle, sheep, goats, swine, horses, dogs, cats. The pedigree of a prized bull, horse, cat, or dog is all about taxonomy and increasing with a more genetic focus. These days we farm raise seafood so that is part of this group too.
- **Forensic taxonomist** - dealing with identification and classification of primarily deceased persons or animals, often using biometrics and DNA to determine species, gender, height, weight, ethnicity, age, and so on for purposes of criminal investigation or archeology. Is that a missing person or just an old coyote skeleton? They may work with entomological taxonomists to determine the age and species of insects at the site.

▪ **Microbial taxonomist** - these are often virologists or bacteriologists. Ever get a flu shot or not sure if your cold is really a flu or not? That's all about taxonomy at a very tiny level. Taxonomists decide what flu strains to put into the vaccine each and every year. E.coli is in all our bodies and needed to be for life. However if we get a tiny bit of a toxic strain of the same species, we get very sick and might even die. That is infraspecific taxonomy at a very important, vital level.

▪ **Soil taxonomist** - those dealing with the classification, naming, and characterization of soils. This taxonomy spans geology (non-living) and biological organisms (living) in soils, the latter being insects, animals (worms, small mammals), and microbes. Soils are traditionally most important for plants but also have numerous influences on human and animal life, both wild and domesticated. Your home construction and flood insurance among other things has much to do with local soil taxonomy.

◦ **Non-biological taxonomist** - those working with non-living, often man-made objects, products, and chemicals.

- **Geological taxonomist** - working with classification of rocks, minerals, petroleum and so on. They have elaborate tools at their command. Do we spend \$50 million to develop this oil well or mine? Is that diamond worth \$1 million, \$100,000, \$1,000, or nothing? That comes down to taxonomy of a type and intersects with product taxonomy when minerals and stones are processed into jewelry.
- **Meteorological taxonomy** - these folks classify storms but perhaps more interestingly the types of clouds in their widely varied shapes, textures, dimensions, and even colors.

Product taxonomist - one who works classifying or grouping non-living products such as cars, airplanes, industrial products, chemicals, software, textiles, computers, and other non-living objects. This should not be confused with a chemotaxonomist who uses chemistry to classify plants and animals. Product taxonomists are called upon to arrange our physical stores are laid out for both ease of shopping and marketing. Why are pickles sometimes with canned vegetables and other times just with ketchup? Study the Periodic Table of Elements in school? That was product taxonomy relating to chemistry. If you shop eBay or Amazon you'll notice that everything comes in hierarchies or classifications that sometimes go 5-20 levels deep. "eBay > Collectibles > Rocks, Fossils, and Minerals > Crystals and Mineral Specimens > Rare Crystal and Mineral Specimens > Shungite" was something I visited today. I went to an auto show recently and there were dozens of Ferrari or Lamborghini models. Some people can identify them by precise model and year in a second. I could not but am working on it. There's an intake here, a different line here, carbon fiber here, and a spoiler there, all morphometric and color descriptors that sort out one model and year from the next. You could easily write dichotomous identification keys to cars, jets, ships, and motorcycles - and people actually do!

- **Food and beverage taxonomist** - one dealing with the styles, presentations, colors, shapes, textures, and chemistry of food and drink products. Obviously this intersects with the agricultural taxonomy when it comes to vegetable or fruit varieties, especially hops and grapes, but also spices, herbs, grains, and breeds of animals. Microbial taxonomy plays a role two in the making of cheese, wine, beer, tea, and other fermented foods. Been to a beer or wine tasting? That is a form of taxonomy, especially if you tried to guess the vintage, varietals, and origins. Breweries scientifically measure color (SRM), bitterness (IBU), specific gravity (OG), and more. That is taxonomy my friends. The plants, animals, and microbes which are essential to our favorite foods have a taxonomy all their own that translates into the commercial products we buy and create for ourselves. I took my knowledge of plant taxonomy and beer and wrote a [beer classification system](#) with 220 "species" if you will. Wikipedia has lots of food taxonomy and one that I use occasionally is a [taxonomy of pasta](#).
- **Art taxonomist** - one who works with man-made art objects such as genres of oil paintings, coins, styles of sculpture, and so on. These people are experts in art history. They determine the genre, era (time frame), style, and other aspects of paintings and often to determine authenticity. A Monet or Rubens will have geometrics, chemistry, stroke angularity, and other taxonomic descriptors just like a plant or animal.
- **Archeological taxonomist** - one who works with ancient, recovered objects such as classifying pottery, jewelry, weapons, and other objects. Is that pot fragment from the Aztec, Mayan, Incan, or a fake/replica? And from which era of the cultures. They also work with taxonomists specializing in geology, art, plant and animals fragments, and commercial products of the long past.

As an exercise, review all the above types of taxonomists and answer if color is important for identification? What about shape? How about chemistry? Is flavor or taste determined by humans important (or even safe)? How about smell? Do they publish uniform standards for terminology and naming?

Do write with your ideas and yes I am open to articles from anyone who wished to contribute a thought or any size. I'm at ornamentals@lycos.com

CHAPTER ONE

CULTIVAR FINGERPRINTING

Before we get too far down this path, let's establish a couple of basic terms for garden plants. Those taxa, cultivars or not, which come from the wild

are called **indigenes** (ie. indiginous) and those which originated in garden as **cultigens** or cultigenic in origin. Liberty Hyde Bailey in 1918 defined indigenes as "of known habitat" or "a species of which we know the nativity - one that is somewhere recorded as indigenous". He added the term cultigen in 1923 and added the familiar term **cultivar** (cultivated variety) at that time. Prior to his creation of the taxon cultivar, cultigens were named botanically, mostly are varieties (var.) and by some authors like Dr. Alfred Rehder as formae (f.).

The use of genetic material, DNA in particular, to examine the innate differences among closely related ornamental taxa has become a useful skill. While it remains a laboratory exercise of some expense and requiring a good deal of training, the promise for greater practicality and lower cost is great. As I type this, I have been quoted fees from \$220 to \$410 per taxa by contract labs that do cultivar-level work. Those prices in for minimum quantities of a few dozen taxa. This is clearly out of range for the average consumer hoping for simply plant identification but perhaps in range for a cultivar development organization (nursery, university, private laboratory) wishing to secure the legal distinctiveness of their creations.

To date, cultivar fingerprinting has the following applications:

- Cultivar identification. More on this in a following paragraphs.
- Similarity measures between and among cultivars, typically the **Coefficient of Similarity**, Cultivar A has a 0.98 similarity to Cultivar B even though it looks closer to Cultivar C (similarly of just 0.62). At what level can or should be consider them identical remains up for debate, especially if the type of analysis may not be as complete as some other techniques and especially if morphology shows some reliable differences.
- Determination of cultivar variability in terms of clonal uniformity, inbreeding, polyclonal formation vs. variability of seedling populations
- Pedigree verification. Are the supposed parents likely or not, even impossible? Generally the female parent is a sure thing if seed is directly harvested. Paternity can be another issue with pollen and insects flying everywhere and not all crosses controlled with barriers or barrier coming down. Perhaps the most famous example of DNA fingerprinting and the overturning of a pedigree is the popular HONEYCRISP® apple. The US plant patent said it was 'M acoun' x 'Honeygold'. But DNA work in 2004 determined that neither cultivar was a parent and that the University of Minnesota's other introduction 'Keepsake' was sure to be one parent. In 2017 more DNA work determined the other parent was the unnamed MN1627, a cross of 'Duchess of Oldenburg' and 'Golden Delicious'. That was a big turn of events.
 - Pedigree duplication. My competitor has a world-class, winning, very profitable hybrid and they are absolutely not talking about it's "complex parentage". Can DNA work and perhaps mass-spec work on fruit reveal the pedigree. There is beginning to be major corporate advantages by duplicating (at least in part) the pedigrees of a proven, new cultivar and then patenting and trademarking it for your firm. But don't patents require identification of parents? Yes and no. If one parent is 'Snow King' who is to say you don't list it in the parent as your accession #43564 and avoiding the name issue altogether. It does go on. If the miracle new cultivar is 'Snow King' x 'Red King' x ? why can't you raise a similar cross, field out 10,000 seedlings, and hope for something as good or better? Why not try.
- Suggestion for resemblant (parallel mutation) and renamed cultivars. Determination of patent/Plant Breeder's Rights theft is a legal matter and in this respect the science is unclear. Technically a selected seedling of a patented cultivar is a new piece of intellectual property and what if it's RAPD looks identical even though the plant's morphology does not! "I'm innocent" he screams to the judge, "They're just mutant seedlings, I swear...RAPD only tells part of the picture"...."Ten years hard labor at Rikers" replies the bench, slamming down his gavel.
- Species affinity of cultivars or likely hybridity, certainly determination of pure, single species assignment
- Patent and PBR enforcement. There are several papers on this but all suggest we have a way to go before fraud, deception, or outright theft of genetic material can be proven and legally enforced. It is certainly a goal of PBR/patent holders and their legal representatives who understand some clones are worth millions of dollars over time. Others are more valuable for the scientific reputation of the breeders and universities

involved. If you're from Metropolis University you don't want you magical, wonderful 'Metropolis Wonder' to be diluted with inferior seedlings, dubious clones, and anything else people want to put your unregistered name on! Given that my sport or seedling of your patented clone is likely to have very similar DNA (and in some cases the very same RAPD or AFLP profile in the case of flower color mutations), what can be proven and at what cost? **Currently one would need both DNA and morphological certainty to a high degree of similarity** to make anything be worth your time in court. And most clever and devious of all though: could I not insert a known marker by genetic engineering to make my creation visually identical to yours but incapable of being shown the same by DNA?

- Generic (genus) affinity in the case of material that may belong to closely related genera
- Evaluate and classify a germplasm or breeding collection. There are a couple of papers on this and the goals are mainly to characterize the breeding stock before it's worked on, establishing a benchmark or base for clonal identity. What do we have to work with? Some of the leading breeding programs are doing this, especially if their germplasm may have some questionable or poorly characterized material that still could be useful. For one thing, you want to get your species affinities and nomenclature down first before a pedigree can be written. You also want to identify hybrids and cytological variations in terms of ploidy by other means. You may also want to do "wide crosses" of genetically different material to minimize the disadvantages of inbreeding and introgression - or you may want to explore some of those as well.
- Genetic evolution, speciation, and introgression. Introgression in Japanese azalea cultivars has been revealed. The formation of species and their separation into subgeneric groups has also been studied.
- Early hybrid detection is curious one. Because many cultivar releases, especially from woody genera, often take many years to develop their long pedigrees. Japanese researchers used RAPD in a breeding program for azaleas and slipper orchids to determine if their early crosses were indeed what they had hoped in terms of parentage, in one case this being verification of bigeneric crossing.

Pedigree verification is a newish thing and one good example is Chad Finn's introduction of the 'Echo' ornamental reflowering blueberry by the USDA and Oregon State University in HortScience 52(2): 368-270 (2019). This was their result:

Parentage of 'Echo' was confirmed by using a fingerprinting set of 10 simple sequence repeat (SSR) markers that we developed at the USDA-ARS NCGR to genotype our blueberry collection (Bassil et al., in preparation). All the alleles amplified in 'Echo' were found in either parent ('Perpetua' and/or ORUS 55-1) (Table 1). One allele, 106, in 'Echo' at SSR 1 was only shared with ORUS 55-1, whereas another allele, 260, at SSR 7 came from 'Perpetua'. This confirms that the pedigree of 'Echo' resulted from the cross between 'Perpetua' and ORUS 55-1.

Why are traditional morphological traits insufficient for cultivar fingerprinting? There are a dozen if some experts are proven true. The most obvious one is the **plastic phenotype** meaning that one underlying, true genotype (unique genetic set) has many expressions that vary with cultural practices, light, fertility, water, soil chemistry, plant age, propagation method, understock, and many other factors in the environment. Ever raise a floricultural cultivar outdoors without all the chemical growth regulators, training, pinching, fertilizer regime, and special culture? Ditto for a bonsai cultivar? The two plants often look nothing alike except maybe for a color or two. The basic theory is that morphology is G + E (Genetics + Environment) while DNA cultivar fingering is just the G or real part. **Epistatic interactions** where one gene is modified or dependent on the expression of another, causing morphology to change under different circumstances. **Pleiotropic effects** occur when a single gene has different effects or expressions. In conifers we have **cultivariancy** where shoots grafted or rooted from the base of a plant tends to produce lower, sometimes trailing or mounded specimens whereas those from upper, vigorous portions may make a more erect, pyramidal to conical plant. These are genetically identical but often

have both radically different habits but also leaf and stem morphology. It is perhaps a form of anatomical inheritance that does not rely on the underlying genetics but cultivariants are not fully understood.

The major **DNA or molecular markers** used today are the following. There are countless modification and subtechniques within each category.

1. PCR-based techniques (RAPD, AP-PCR, STMS)
2. DNA sequencing (SNP)
3. Restriction Fragment Length Polymorphism (RFLP)
4. Combinations of PCR and RFLP (Amplified Fragment Length Polymorphism=AFLP)

The **origins of cultivars based on DNA** are so much a mess and mystery in thousands of cases. A thousand research studies and papers are required. Interesting paper set out to determine if the garden Prunus x yedoensis 'Somei-yoshino' was in fact related to the wild species Prunus spachiana.

https://www.jstage.jst.go.jp/article/jsbbs/advpub/0/advpub_19078/_pdf

Tsuruta, M. and Mukai, Y., 2019. Fine mapping of a locus presumably involved in hybrid inviability (HIs-1) between flowering cherry cultivar Cerasus× yedoensis ‘Somei-yoshino’and its wild relative C. spachiana. Breeding Science, p.19078.

Is cultivar, especially monoclonal cultivar-level fingerprinting possible or practical? The answer is yes in some cases, no in others, always difficult it seems. Nyhom in DNA Fingerprinting in Reference Module In Life Sciences (2017) says "the ability to identify mutants remains very low since observed mutations usually involve one locus or a few loci. Chances of finding a marker for exactly that locus (or those loci) are quite small, especially since marker polymorphism often originated from noncoding sequences". Wow! He does note that rose cultivar work has been successful because of the wide genetic variation in that genus. Using up to 400 polymorphic bands with AFLP is "the most convenient methods and has used for analyses of sets of 100 or more cultivars". He further notes than DNA fingerprints cannot yet serve as a "plant passport" for new cultivars and is not recognized by UPOV for registration or discrimination of cultivars.

Should we even attempt cultivar identification from unknown, unlabeled material? The answer is yes but with with qualifications. From my way of thinking, these should include these principles:

- Never rename existing nursery stock when the truly named cultivar is available elsewhere and with proper documentation. Propagate it from scratch with better documented material of proven origins and a chain of correct of labels. Go back to the originator or originating garden when possible for new propagation material. Telling your granny she probably has Rose X is very different from telling a grower with 100,000 rose bushes what to label his stock for worldwide sales!
- Always respect the rights and intent of the originator and this means not diluting or weakening their cultivar clone but raising it from seed or selling seed as some eBay fools will do with "no guarantee it will come true". You have a right to name a new clone or strain yourself and characterize it anew in detail. When it doubt make it your own and be specific how it differs from existing stuff, hopefully improved.
- Like a constitutional legal scholar look for original intent. Did the originator describe it or better yet have a picture in his catalog? Did the author of the book get his/her data from an older source? Did a subsequent author study it further and describe it better? Are there any herbarium specimens around that show definitive characters? Is the garden or nursery of origin still around and you can check for matching material. I found living specimens of Juniper cited by van Melle in 1947 in the 1980's. Same tag name, same location, planted long before 1947.
- Take the stock to the best available experts in the species or genus. They probably have studied dozens if not thousands of the cultivar in question and will often have good reasons not published. "I always tell them apart by checking...." or "A has [this] and B never does".

- Express the identification in terms of a probability, giving weight to laboratory analysis, anatomy, morphology, and historical evidence. Use as many types of analysis as you can do and afford.
- Document the heck out of the knowns and unknowns for future researchers to benefit. Deposit voucher specimens with a reliable university, donate plants to stable, large plant collections, and if possible do both digital photographs and flatbed scans of the material.
- Name to a Cultivar Group level, a phrase like "aff. 'Bronco'" referring to an affinity but no perfect match, or offer under your collection number only. Avoid this when involving trademarked or patented material as these produce legal ramifications if the affinity is not correct nor welcome.
- When in doubt, rename the plant under question with a new name.

One of promises we have in ornamentals fingerprinting is that so many of the heavily studied genera in pomology, herbology, and forestry have important ornamental relatives that will benefit from this existing science. These genera include Malus, Prunus, Musa, Pinus, Picea, Cryptomeria, Mentha, and Ipomoea.

Researchers in cultivar fingerprinting sometimes speak of an **original or initial variety (IV)** and its product or **essentially derived variety (EDV)** with various measures of similarity among them. Experts are wanting to set guidelines that a true cultivar, hopefully cloned with good technology will have specific bands or alleles or profiles to be considered true. Anything lacking specific defined bands, alleles, or profiles will be considered untrue or perhaps an EDV. In future years, these determinations of identification, true or false, are likely to be more rigidly defined and a matter of both law and science.

What is the future of ornamental plant DNA work?

- We also know more and more genera are having a **full genome sequence** created. The American Dahlia Society for example raised \$52,000 to have garden taxa and species sequenced, <https://dahlia.org/wp-content/uploads/2018/01/Genome.pdf>, and this will probably happen in all the major and minor societies before long. By the way, just because some botanist in Japan or a geneticist in Russia has sequenced your genus, does not mean the data will be helpful in dealing with garden cultivars, their known mutations, gene combinations, and unique circumstances. Wikipedia of all places has a list of which plant genera have been sequenced and where to find the results: https://en.wikipedia.org/wiki/List_of_sequenced_plant_genomes
- I was also predict that **cultivar fingerprinting will get cheaper** from the \$425 per taxa/sample I was recently quoted. Machines are getting faster at this and I predict once we hit the \$100 level or lower, more people will step up to fund research.
- **Fingerprinting techniques will get better** and be more precise and definitive as the infraspecific level. We will have a more reliable set of markers for every genus and species because we know what works and what is not so helpful. The science, most of all, will improve year to year.
- **Fingerprinting services will cover ornamental plants.** They already cover non-ornamental crops such as this lab at UC Davis: <https://fps.ucdavis.edu/dnamain.cfm>
- **More managed cultivars (germplasm distribution control):** this is where a special, usually commercially valuable clone is protected not only with patents and registered trademarks but the parent licenses and authorization for propagation is highly restricted, meaning there is a control on where the DNA goes and who can grow it. So far this mainly is about a particular state breeding program allowing only its growers within its geographic boundaries from buying licensed material, effectively shutting off the other fruit producing states from getting their hands on the trees and the charming produce. Obviously patents will run out but there is space of time when only the taxpayers (as it were) benefit from the sale and production of the cultivar even though the fruit might be exported anywhere. From a grower's association viewpoint: **"why should our association's long-term funding of a breeding program and our tax money in general go to benefit competitors out of state or in another**

country?" Good point. Economic controls on special DNA is already in the pomology world and may come to the ornamental realm too. Let me know if you have examples. I have been told of some examples but can't put them in writing for lack of proof and the liability that brings to any author without proof.

- We will get smarter about the **Whose DNA?** question with researchers documenting the accessions they used and vouchering herbarium material as well a **cryopreserving** it for future researchers. We have problems what is the **species standard** in some studies, the best of these going to truly wild-collected material in comparison to garden material. Badly sourced and wrongly named plants give us bad DNA results no matter how good the lab and techniques.
- So-called **DNA barcoding of plants** in terms of their genetic traits and that means garden specimens will be studied as individuals and these notes on perhaps an **RF chip** your phone or other device can read. There could be an actual barcode on the plant's label to access the DNA barcode from a remote database. We may have a simpler form of this first in terms of the genetics of a cultivar as we do with the system of rating tomatoes for various bred-in, genetic resistances, something like Cornus 'Southern Magic' A,P,B meaning it has anthracnose, powdery mildew, and borer resistant genes. I might buy that one if Cornus 'Spring Majesty' just had an A only tag.
- **Is it just ornamental by the DNA?** Folks are growing hemp where it's now legal and the taxa are quite ornamental at times. In one study of more than 120 hemp and THC-infused Cannabis cultivars, the hemp cultivars and strains were easily sorted out without any THC chemotaxonomy. There are ornamental Cannabis of both chemistries, some with purple and red showy leaves, others dwarf, some columnar, some more incised of blade (even thready or filiform), and so on. Yes, there are stable, variegated sport of Cannabis and these can be cloned by rooting or likely TC. I think both THC analysis and DNA will play a role in any future potential of ornamental Cannabis and it's hundreds of cultivars, strains, and interspecific hybrids. Think of hemp as a ornamental, annual Japanese maple which can later be made in soap, clothes, and rope.
- **More GMO plants, including ornamentals.** As edibles this is one concern but as ornamentals do we have less risk? And what of edible-ornamentals? Remember that artificial, non-breeding derived GMO animals only date from 1973 and in the plant world must less time ago. There are tales of mouse genes being put into carrots in the 70's but I can't prove that. Also the venom of wasps being put into potato foliage to kill anything that snacks on the leaf but leaving the tuber pure and clean - maybe? The first official GMO plant was the FLAVR SAVR tomato only about 1993 by Calgene. Where bigeneric crosses the old-fashioned way fail us, especially between plant families, GMO will be a major temptation. The blue and violet-colored rose will happen sooner or later if not already. There is one American professor who can put weird, atypical flower scents into almost any species he wants. Heard something about a peanut butter-scented Petunia and roses that don't smell like a rose but as just as fine. These are coming up soon. I predict **most of the GMO ornamentals will need to be sterile** (perhaps triploids) and with low invasive qualities in terms of rhizomatous behavior (spreading vs. clumping). There are papers on **transgenic ornamentals** if you want to look for them. Dr. Hammond with a rounded knowledge of garden plants from the U.S. National Arboretum is a good place to start: <https://naldc.nal.usda.gov/download/25775/PDF>
- **Patenting of genes for ornamentals** and not just clone or seed strains. I develop a really useful gene or set of genes and some yahoo somewhere raises a seedling that looks a bit different (gets patented) and with tissue culture has it on the market in two years. I'd rather protect my deep, underlying, important genes than just a specific clone or two or their names! As things stand in 2019, the U.S. Supreme Court rules that naturally-occurring genes could not be patented here (thus overturning rights of some of the 4300 human gene parents) but man-created genes as the result of human effort and genetic engineering were a unique work of individual people and could be protected.

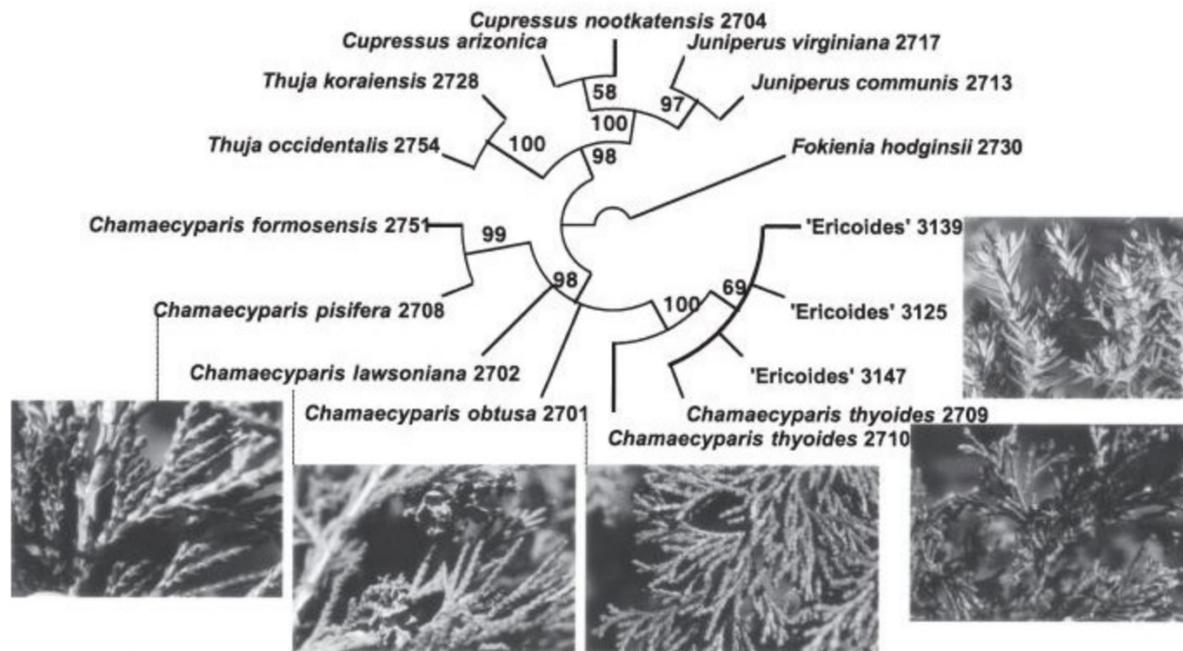


Fig. 1. Strict consensus of six trees of 791 steps based on nrDNA ITS data set (CI = 0.79, RI = 0.86). Numbers at branches are bootstrap percentages, and those following each sample name refer to JLI's DNA bank accession numbers.

Li, J., Ledger, J., Del Tredici, P. and Zhang, D., 2004. Identification of a heath-leaved cypress cultivar based on sequences of nuclear ribosomal DNA. *HortScience*, 39(6), pp.1217-1219.

<https://journals.ashs.org/hortsci/downloadpdf/journals/hortsci/39/6/article-p1217.pdf>

This is a very important paper and one that settled an argument maybe 200 years in the making. This cultivar called 'Ericoides' was up for grabs. Some consider it a juvenile Thuja while others said Chamaecyparis and some older authors a Juniperus. It had also circulated widely for years as Cupressus ericoides. Using nuclear ribosomal DNA the right genus was determined and also the correct species, that being Chamaecyparis thyoides, which with gray to blue scaly foliage hardly looks like a potential parent. One of their plates is shown above. Note how they "went wide" and studied different genera including the very distant Fokienia. It should be noted that this DNA analysis followed a more traditional morphological and anatomical study listed below that drew the same conclusion with different evidence.

Miller, R.B. and Meyer, F.G., 1989. Identification of the heath-leaved Cypress, Chamaecyparis thyoides 'Ericoides' (Cupressaceae). *Baileya*, 23(2), pp.57-67.

<https://www.fpl.fs.fed.us/documnts/pdf1989/mille89a.pdf>

ORNAMENTALES, I.D.G.D.E., 2001. Genotype identification of ornamental species by RAPD analysis. *Acta horticulturae*, (546), p.391.

https://www.researchgate.net/profile/Gianluca_Burchi/publication/284707686_GENOTYPE_IDENTIFICATION_OF_ORNAMENTAL_SPECIES_BY_RAPD_ANALYSIS/links/57f226b008ae886b89792725.pdf

This is paper covering several genera but I found a few results more than interesting. RAPD and PCR were both employed. Roses 'Anna' and 'Virginia' could not be separated by their method although they have different flower colors. We have seen a similar result before where the DNA work does not seem to sample the genes controlling petal color. 'Virginia' as a sport 'Anna' and so closely related, changing only a few genes perhaps. This is a concern in closely related ornamental cultivars which sport from one parent, then again, and sometimes five or six generations of mutations in a line.

Gawel, N.J., Johnson, G.R. and Sauve, R., 1996. Identification of genetic diversity among *Loropetalum chinense* var. *rubrum* introductions. *Journal of Environmental Horticulture*, 14(1), pp.38-41.

<https://www.hrjournal.org/doi/pdf/10.24266/0738-2898-14.1.38>

This is an interesting applied study that is rich in cultivar history as well and modern taxonomy. They went back to early US introduction of var.

rubrum to the US and documented them. I was around in 1989 and 1990 when J.C. Raulston received some of the first material for US evaluation, this species being very cold hardy and vigorous in Raleigh, North Carolina. We have trees of the green and red stuff easily 15 feet tall in 2019. Quite importantly they considered morphological evidence from literature and their own observations and not just RAPD on it's own. An important paper. It's important to note that other countries do not always use western names and so this Chinese evaluation of var. rubrum is very useful too.

Li, D., Yu, X., Xiong, X., Peng, J., Li, Y., Zhang, H. and Chen, H., 2010. Classification of *Loropetalum chinense* var. *rubrum* based on AFLP analysis. *Journal of Hunan Agricultural University*, 36(2), pp.169-175.

Hsiang, T. and Huang, J., 2000. The use of RAPD markers to distinguish among juniper and cedar cultivars. *Canadian Journal of Botany*, 78(5), pp.655-659.

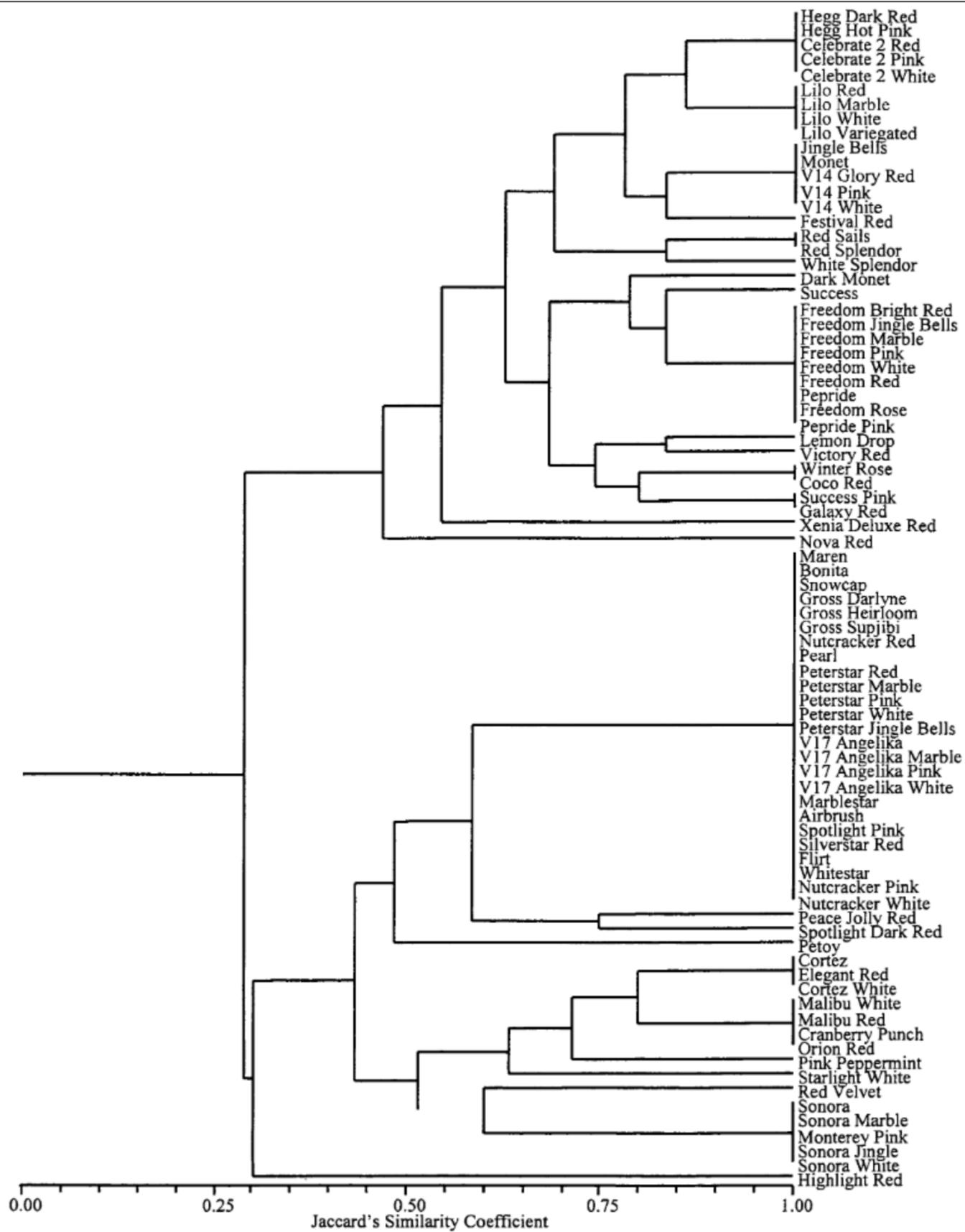
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.408.1998&rep=rep1&type=pdf>

This paper is interesting and it spans two *Juniperus* species and also related *Chamaecyparis* cultivars.

***Euphorbia pulcherrima* (Poinsettia) and *Impatiens* (New Guinea Group).**

<https://www.slideserve.com/MikeCarlo/fingerprinting-and-markers-for-floral-crop-improvement>

James W. Moyer was a Professor of Plant Pathology at North Carolina State University (now Dean of Agricultural Research at Washington State University) and while not in the Department of Horticultural Sciences he and his associates managed to work out the cultivar ID of Poinsettia and New Guinea Impatiens (NGI) cultivars to a shockingly precise degree. This PowerPoint (PPT) presentation is immensely informative on these plants and the technology in general. He looked at 117 *Euphorbia pulcherrima* cultivars with 41 different AFLP fragments and used multiple plants per cultivar for quality control. Color sports cluster with the parent cultivar, breeding families from the same nursery cluster together. In the NGI study he used 168 cultivars and needed 95 fragments to get definitive separation. Typically AFLP needs 40-100 fragments to get a good answer and because some of the technology is patented this is an expensive and time-consuming process. Moyer patented his technique with respect to Poinsettia system and database in the US as #7695901B2. Because patent data is not subject to copyright I am free to share his Poinsettia cultivar dendrogram:



<https://patents.google.com/patent/US7695901B2/en>

Windham, M.T. and Trigiano, R.N., 1998. Are 'Barton' and 'Cloud 9' the same cultivar of *Cornus florida* L.? *Journal of Environmental Horticulture*, 16(3), pp.163-166.

<https://www.hrijournal.org/doi/pdf/10.24266/0738-2898-16.3.163>

'Barton' and 'Cloud Nine' generally indistinguishable.

and following up with

Trigiano, R.N., Ament, M.H., Windham, M.T. and Moulton, J.K., 2004. Genetic profiling of red-bracted *Cornus kousa* cultivars indicates significant cultivar synonymy. HortScience, 39(3), pp.489-492.

<https://journals.ashs.org/hortsci/downloadpdf/journals/hortsci/39/3/article-p489.xml>

'Satomi', 'Heart Throb', 'Rosabella' identical, either very closely related, perhaps seedlings or just renames? 'Satomi' in my opinion (this is my analysis) is an old Japanese name and not a very commercial one at that. These other names are subject to rejection but can we be sure? At what point would a seedling selection of 'Satomi' with DNA identical with these specific markings be considered a truly identical thus synonymous cultivar? Suppose one has a gene for more flowers. Does that show up with these markers? These will be weighty and controversial decisions in future cultivar-level taxonomy when plant patents, PBR, registered trademarks, and other legal controls are involved. Phytotaxonomy meets Commerce and The Lawman. That's a show coming to a courtroom near you very soon.

Rzepka-Plevneš, D., Smolik, M. and Drzewiecka, K., 2007. Genetic variation of some botanical and cultivar varieties of *Acer* sp. JFAE, 5(3-4), pp.481-485.

Yes friends there are cultivar-level separations of Japanese maple cultivars using modern methods. In this paper 'Dissectum Atropurpureum' and 'Garnet' showed only 50% similarity which are far less than the human eye tells us. Also 'Dissectum Ornatum' and 'Atropurpureum' had similarity of just 34% so there is more to one or two leaf incision genes going on. In this study 'Dissectum Atropurpureum' and 'Dissectum Ornatum' were evaluated as two different taxa but nomenclaturally they were originally synonyms as imported from Japan, their former clone must be one of many things under the name. Another good paper on similar taxa is this one from Japan:

Kanzaki, S., Inoue, K., Utsunomiya, N. and Yano, M., 2013. Cultivar identification and analysis of genetic relationships of Japanese maples using simple sequence repeat (SSR) markers. Horticultural Research (Japan), 12(1), pp.1-7.

Krahl, K.H., Dirr, M.A., Halward, T.M., Kochert, G.D. and Randle, W.M., 1993. Use of single-primer DNA amplifications for the identification of red maple (*Acer rubrum* L.) cultivars. Journal of Environmental Horticulture, 11(2), pp.89-92.

<https://www.hrijournal.org/doi/pdf/10.24266/0738-2898-11.2.89>

A very successful study that was able to separate out all the cultivars studied. Interesting how a couple of cultivars clustered close to wild material. I find this a model study in the separation of shade tree cultivars.

Mcharo, M., Bush, E., La Bonte, D., Broussard, C. and Urbatsch, L., 2003. Molecular and morphological investigation of ornamental liriopogons. Journal of the American Society for Horticultural Science, 128(4), pp.575-577.

<https://journals.ashs.org/jashs/abstract/journals/jashs/128/4/article-p575.xml>

An interesting and useful study as Liriope and Ophiopogon have such subtle, small parts and are very plastic in terms of their phenotypes. Their taxonomy is difficult and has been confused for two hundred years. They used AFLP on 18 commercially important taxa including some cultivars recently introduced at the time. They doubt that two distinct genera are necessary. It is mainly the epigynous or perigynous type of flower in the morphological world that separates the two genera out. Some taxa are more semi-epigynous, showing intermediacy. They have a very neat dendrogram. The highest level of similarity at 0.57 was between the 'Blue Blue'/'Silver Dragon' groups and the 'Samantha'/'Variegata' group. The lowest level of similarity (0.23) was between black and mini mundos of Ophiopogon. In fact, their standard for Mondograss and Variegated Mondo clustered with the Liriope cultivars and not with the blackmonod or minimondo, widely considered to be the same species in gardens! Close on the heels of this work is additional insight on Liriope from the quartet of stars that are Lattier, Ranney, Fantz, and Ament:

Lattier, J.D., Ranney, T.G., Fantz, P.R. and Avent, T., 2014. Identification, nomenclature, genome sizes, and ploidy levels of *Liriope* and *Ophiopogon* taxa. *HortScience*, 49(2), pp.145-151.

<https://journals.ashs.org/hortsci/view/journals/hortsci/49/2/article-p145.xml>

Genome size from scores of specifically identified accessions are reported and the results are fascinating. I will pick one point about *Liriope gigantea* for it's not found anywhere in the wild, was first found in a French garden, and is not known to the botanical community. It is clearly a cultigen of no botanical standing. It is pretty much what I am calling *Liriope muscari Gigantea* Group, very much a straight forward tetraploid in a genus where size of everything is valued. The popular cultivar 'Aztec' is not a *Liriope* at all and belongs to *Ophiopogon intermedius*.

Adams, R.P., Arnold, M.A., King, A.R., Denny, G.C. and Creech, D., 2012. *Taxodium* (Cupressaceae): One, two or three species? Evidence from DNA sequences and terpenoids. *Phytologia*, 94, pp.159-168.

<https://www.juniperus.org/uploads/2/2/6/3/22639912/278.pdf>

This is not cultivar level stuff but very important to the framework of assigning cultivars to the right varieties, subspecies, or species in the genus *Taxodium*. Heavy hitters like Drs. Robert Adams and David Creech set down for all time the conclusion that we have on monotypic (single species) situations with three different varieties. Note that they employed two major taxonomic techniques, chemotaxonomy of terpenes and DNA. This to me a very major, significant paper for any conifer or woody plant taxonomist, a perfect model for future work.

Le Duc, A., Adams, R.P. and Zhong, M., 1999. Using random amplification of polymorphic DNA for a taxonomic reevaluation of Pfitzer Junipers. *HortScience*, 34(6), pp.1123-1125.

<https://www.juniperus.org/uploads/2/2/6/3/22639912/156-1999hort341123.pdf>

This is a very valuable paper since garden juniper taxonomy can be very difficult due to the small leaves, plastic phenotypes, commonplace shearing of plants (even in collections!), subtle leaf colors, and so on. *Juniperus x media* 'Pfitzeriana' (incorrectly as *J. x pfitzernana* 'Wilhelm Pfitzer') as a group was verified to be a cross of *J. chinensis* and *J. sabina* but evaluating seven of it's known clonal selections. Just for the record, van Melle's *J. x media* cannot be rejected because the earlier Russian *J. media* Dmitriov was never validly published in an internationally known or distributed journal, just one a few Russian libraries had. Peter J. van Melle was "just a nurseryman" and a fairly confrontational American with more evidence than tact. He as a hard-working, very diligent and very precise amateur taxonomist of the best kind. His name being overturned suits the European botanical community just fine and it's frankly too political to even bring up in some settings. 'Hetzii' fit the general Pfitzer Group but was an outlier giving that it's triploid and thought to be a cross of *J. x media* 'Pfitzeriana' and *J. virginiana* 'Glauca'. Just recently Dr. Adams and his colleagues did more work on Pfitzer junipers in the link shown below:

https://www.juniperus.org/uploads/2/2/6/3/22639912/416._-_phyto101_2_164-174adamsetal_xfitzeriana_w_2_seagreen_6-11-19.pdf

Most of the 'Pfitzer' clones are tetraploid, meaning it likely had two tetraploid parents. I was not shocked that 'Sea Green' was not shown to be a clear member of the Pfitzer clan and though it has generally habit and foliage similarity, it's likely not a direct sport of 'Pfitzeriana' or it's clones. 'Sea Green' is a female and all the Pfitzer clones are males in this dioecious genus. They put forth the theory that triploid 'Sea Green' is a backcross to *J. chinensis* and given it's morphology and intense green shades like *J. chinensis* var. *chinensis* of gardens, this seems like a very viable thought. By the way, MINT JULEP in some stock is identical to 'Sea Green'. I was surprised that 'Old Gold' had some odd matching too since it's thought to be a direct 'Pfitzeriana Aurea' sport or perhaps a sport of one of it's sport. *Juniperus sabina* var. *balkanensis* is most likely the exact variety which gave rise to this popular grown of hybrids, partly because it's a tetraploid and the other Pfitzer parent was a tetraploid *J. chinensis*. Many garden Chinese junipers are diploid but some other populations and clones like 'Kaizuka' are tetraploids.

Some of the more useful and informative papers on this subject are the following, sorted by genus or species in red.

Krahl, K.H., Dirr, M.A., Halward, T.M., Kochert, G.D. and Randle, W.M., 1993. Use of single-primer DNA amplifications for the identification of red maple (*Acer rubrum* L.) cultivars. *Journal of Environmental Horticulture*, 11(2), pp.89-92.

Ranamukhaarachchi, D.G., Henny, R.J., Guy, C.L. and Li, Q.B., 2001. DNA fingerprinting to identify nine *Anthurium* pot plant cultivars and examine their genetic relationship. *HortScience*, 36(4), pp.758-760.

Côté, M.J. and Leduc, L., 2007. Molecular identification of Japanese barberry (*Berberis thunbergii*) cultivars using amplified fragment length polymorphism. *HortScience*, 42(3), pp.478-482.

Schenk, M.F., Thienpont, C.N., Koopman, W.J., Gilissen, L.J. and Smulders, M.J., 2008. Phylogenetic relationships in *Betula* (Betulaceae) based on AFLP markers. *Tree Genetics & Genomes*, 4(4), p.911.

<https://link.springer.com/article/10.1007/s11295-008-0162-0>

LOH, J.P., KIEW, R., KEE, A., GAN, L.H. and GAN, Y.Y., 1999. Amplified fragment length polymorphism (AFLP) provides molecular markers for the identification of *Caladium bicolor* cultivars. *Annals of Botany*, 84(2), pp.155-161.

Chao, C.C.T., Devanand, P.S. and Chen, J., 2005. AFLP analysis of genetic relationships among *Calathea* species and cultivars. *Plant Science*, 168(6), pp.1459-1469.

Gardner, N. and Hokanson, S.C., 2005. Intersimple sequence repeat fingerprinting and genetic variation in a collection of *Clematis* cultivars and commercial germplasm. *HortScience*, 40(7), pp.1982-1987.

Smith, N.R., Trigiano, R.N., Windham, M.T., Lamour, K.H., Finley, L.S., Wang, X. and Rinehart, T.A., 2007. AFLP markers identify *Cornus florida* cultivars and lines. *Journal of the American Society for Horticultural Science*, 132(1), pp.90-96.

Chen, J., Henny, R.J., Norman, D.J., Devanand, P.S. and Chao, C.C.T., 2004. Analysis of genetic relatedness of *Dieffenbachia* cultivars using AFLP markers. *Journal of the American Society for Horticultural Science*, 129(1), pp.81-87.

Vainstein, A., Hille, J., Lavi, U. and Tzuri, G., 1991. Assessment of genetic relatedness in carnation by DNA fingerprint analysis. *Euphytica*, 56(3), pp.225-229. (*Dianthus*)

Li, W., Shi-Yan, X.I.N.G., Ke-Qiang, Y.A.N.G., Zheng-Hua, W.A.N.G., Yan-Yan, G.U.O. and Huai-Rui, S.H.U., 2006. Genetic relationships of ornamental cultivars of *Ginkgo biloba* analyzed by AFLP techniques. *Acta Genetica Sinica*, 33(11), pp.1020-1026.

Sauve, R.J., Zhou, S., Yu, Y. and Schmid, W.G., 2005. Randomly amplified polymorphic DNA analysis in the genus *Hosta*. *HortScience*, 40(5), pp.1243-1245.

Ashworth, V.E., O'brien, B.C. and Friar, E.A., 1999. Fingerprinting *Juniperus communis* L. cultivars using RAPD markers. Madrono, pp.134-141.

Cai M, Pan HT, Wang XF, He D, Wang XY, Wang XJ, Zhang QX. Development of novel microsatellites in *Lagerstroemia indica* and DNA fingerprinting in Chinese Lagerstroemia cultivars. Scientia Horticulturae. 2011 Nov 22;131:88-94.

Bauer, H. and Treutter, D., 1990. Identification of Pelargonium genotypes by phenolic 'fingerprints'. II. Cultivar identification by HPLC analysis of leaf phenols combined with discriminant analysis. Gartenbauwissenschaft, 55(4), pp.187-191.

Hu, D., Zhang, Z., Zhang, Q., Zhang, D. and Li, J., 2005, January. Ornamental peach and its genetic relationships revealed by inter-simple sequence repeat (ISSR) fingerprints. In VI International Peach Symposium 713 (pp. 113-120). (*Prunus persica*)

Junwei, Z., Yurong, C. and Manzhu, B., 2004. RAPD Identification and Discrimination of 42 Ornamental Pink Double Form Cultivars of *Prunus mume* Sieb. et Zucc. Acta Horticulturae Sinica, 31(4), pp.487-490.

Ben-Meir, H. and Vainstein, A., 1994. Assessment of genetic relatedness in roses by DNA fingerprint analysis. Scientia horticulturae, 58(1-2), pp.115-121. (*Rosa*)

CHAPTER TWO

CULTIVAR-LEVEL CLADOMETRICS

The more we measure the more we understand. This is true in all branches of science. It was only our inability to measure with precision and in both small and large scales that held technology back for so many centuries. People in horticulture including taxonomists give up saying "so many cultivars looked alike". That is partly true but mostly true because no one has actually measured them with enough precision and detail to determine their real, reliable, and stable differences. We don't know and give up and get confused because we are not trying hard enough. It is a pain, an inconvenience, and means untold hours of measuring and data tabulation. But sometimes it's the best way and without a massive DNA or chemotax lab, the only way.

Cladometrics is the measurement of branches and branchlets. It not the same as cladistics which makes tree diagrams or dendrograms in numerical taxonomy. There is a good deal of scholarly literature of architecture of trees, especially in the field of forestry as well as general plant branching work in floriculture, pomology, and agronomy. Basal branching affects crop yields as does the architecture of heavily trained crops like grape vines and apple trees. Some of this progresses or perhaps just degenerates into mathematic equations of limited practicality. In general, the principles involve minimum vs. maximum shoot lengths in different orders of primary, secondary, and tertiary positions as well as the number of these shoots at each level. It needs to be only as complex and mathematical as one requires.

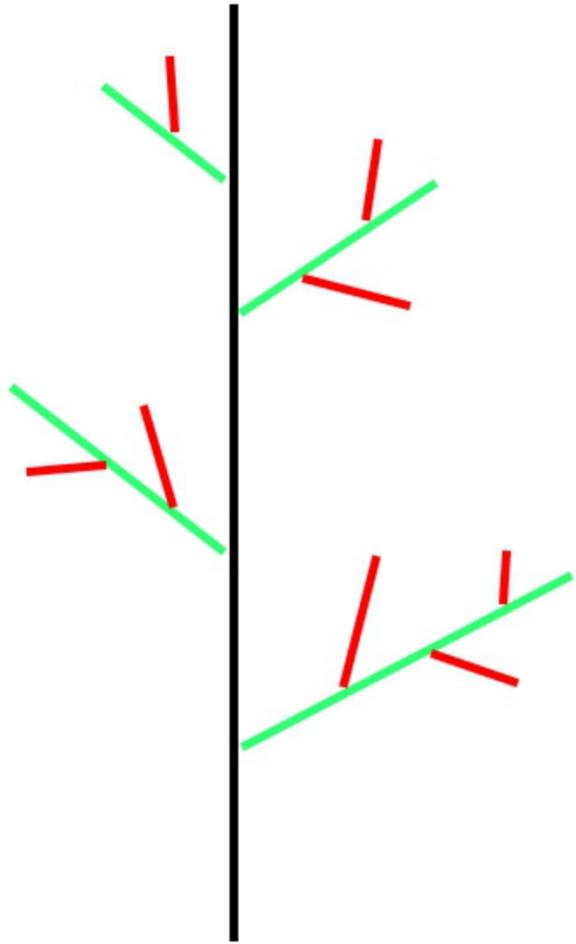
I first developed a simple system when completing my Masters of Science thesis on *Juniperus horizontalis* cultivars at North Carolina State University, a work which evaluated 54 different cultivars in all. Habit, foliage color, and leaf divergence also were incorporated into the grouping of cultivars. Drs. Paul Fantz (horticultural taxonomist/pla), J.C. Raulston (woody plant expert and developer), and James Hardin (woody plant taxonomist and then

Chief Editor of Systematic Botany) were my major inspirations. Robert J. Rouse, also working with Professor Fantz applied some of this system and expanded it with his definitive separation of Cryptomedia cultivars in the following paper. His very detailed, precise cladometric descriptions have proven valuable in a very complex and difficult genus.

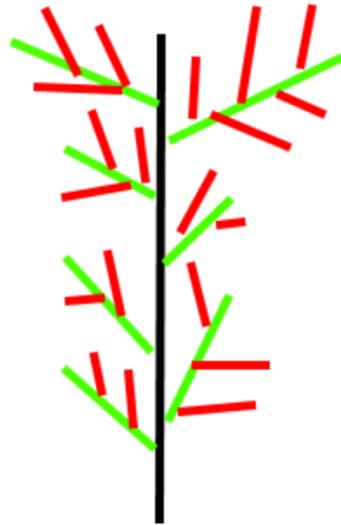
<https://journals.ashs.org/horttech/downloadpdf/journals/horttech/10/2/article-p252.xml>

Rouse, R.J., Fantz, P.R. and Bilderback, T.E., 2000. Descriptions and a key to cultivars of Japanese cedar cultivated in the eastern United States. HortTechnology, 10(2), pp.252-266.

Let's start with a basic exercise. The following is the branching pattern of Cultivar A:



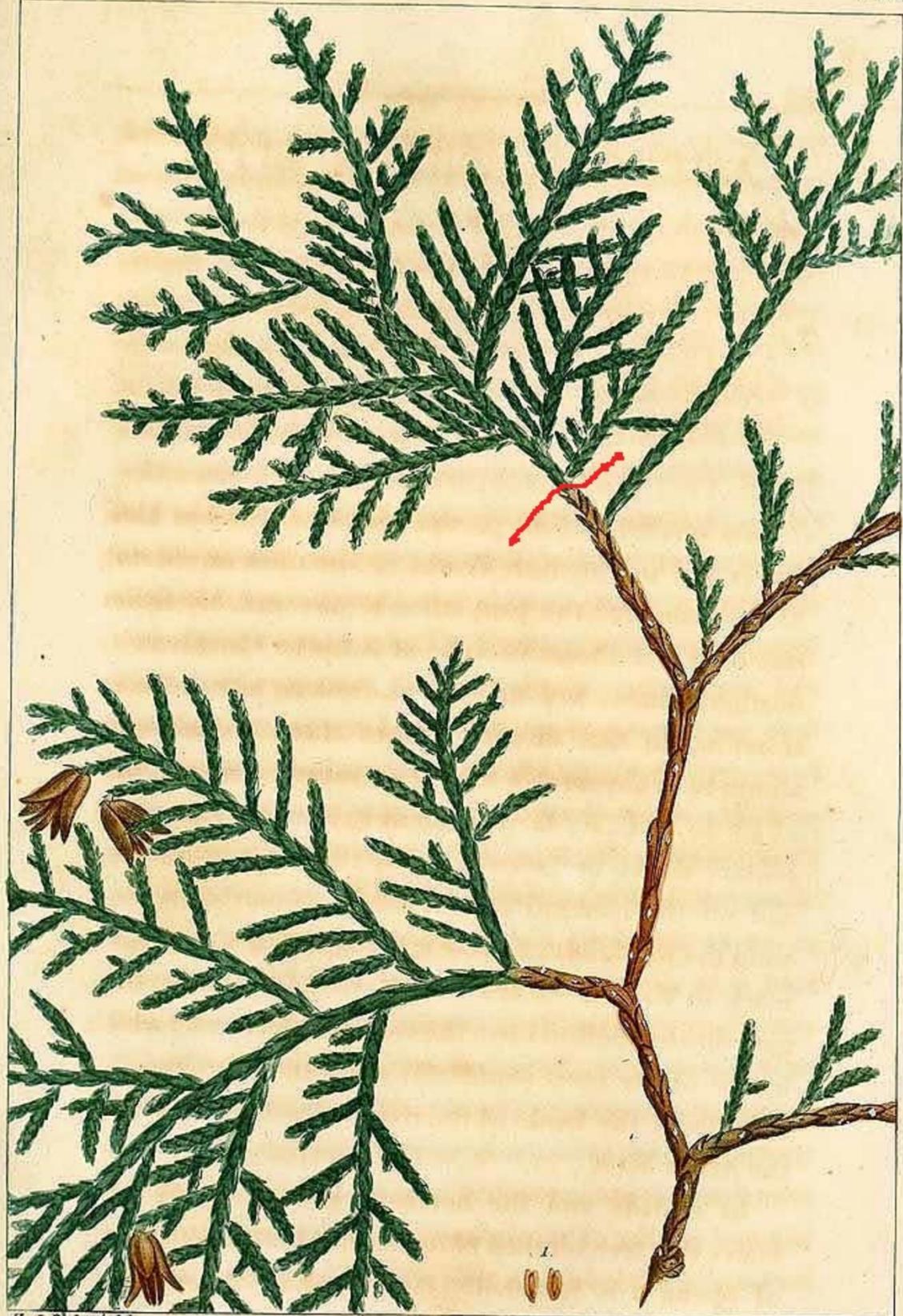
The green shoots are the secondary ones off the annual growth increment in black. The red shoots are the tertiary shoots or tertiaries. How many secondary shoots per growth increment? How long is the longest secondary (apply a ruler to your screen)? What is the maximum number of tertiaries on any secondary shoot? How long is it the largest tertiary?



Here is a dwarf mutation called Cultivar B. How many secondary shoots per growth increment? How long is the longest secondary (apply a ruler to your screen)? What is the maximum number of tertiaries on any secondary shoot? How long is it the largest tertiary? The values in the chart are approximate because this file can be magnified or displayed different ways. Not also that the dwarf cultivars tends to have more tertiaries in the distal or upper half of the secondary shoot. That is a common strategy of branching in the Cupressaceae, especially *Thuja occidentalis*.

Descriptor or Metric	A	B
# secondaries (2#)	4	6
Longest secondary (2L)	3.7	2.1
Max # tertiaries (3#) on any secondary	3	5
Longest tertiary (3L)(cm)	1.6	1

This simple example gives us the basis for some cladimetric taxonomy at the cultivar level. It is realistic example with cultivar A being like a species with a pyramidal shoot and the dwarf mutation with a denser, fan-shaped or wedge-shaped shoot. We can also get more data from the length of annual growth increment (black line) as well as the spacing between the two lowermost secondary shoots.



Arbor vitæ or White cedar.
Thuja occidentalis.

To illustrate how robust and practical this style of cladometrics is I selected a plate from 1819 from Michaux's North American Sylva for *Thuja occidentalis*. I marked off the current year's growth increment with a red line to make the metrics a bit easier. How many secondaries do we have? Again, how long is the longest secondary shoot? Tertiary? What is the max number of tertiaries on one secondary shoot? Three of secondaries are

very short at the top so the count should be 10 not 7. Notice this example has quarternary or 4th order branching too but they are only 3-6mm long. If we decide to call this Taxa C our chart would now look like this:

Descriptor or Metric	A	B	C
# secondaries (2#)	4	6	10
Longest secondary (2L)	3.7	2.1	6.5
Max # tertiaries (3#) on any secondary (3L)	3	5	15
Longest tertiary (3L)(cm)	1.6	1.0	1.8

Recommended metrics or descriptors for the cultivar variations of the Cupressaceae and other highly branched cultivars.

- **Annual Growth Increment (AGI)** = length of annual growth shoot or increment (must be measured at a defined time, perhaps July or August)
- Secondary branchlets
 - Number of each (range and mean)(2#)
 - Length of longest one (usual oldest or basal)(2L)
 - Angle to main growth shoot(2A)
- Tertiary branchlets
 - Number of each (range and mean)(3#)
 - Length of longest one (usually oldest or basal)(3L)
- Quarternary branchlets (if they exist)
 - Number of each (4#)
 - Length of longest one (usually oldest or basal)(4L)

It should be stated that cladometrics at the exclusion of other morphological traits does not work well in Juniperus or Cryptomeria. **Leaf length, leaf divergence** (angle from stem, that is spiny vs. scaly, adult vs. juvenile), and **foliage spray coloration** (degree of glaucousness or olive tones). Foliage spray coloration is not the same as leaf color because of the role of pale stomatal bands, stem color, and different colors within one leaf; all these contributing to the entire foliage mass and it's hue. In recent years, we have found that a JPG image of the entire plant can be sampled for RGB colors to get this overall impression of color, giving maybe 2-7 values per cultivar. It must be noted that both Juniperus and Chamaecyparis derive blue or gray coloration from both stomatal bands and glaucousness or wax on the leaves. The most silvery or frosty blue cultivars will have both. Cupressus also adds a third source of pale, bright color, this being whitish resin deposits.

The importance of measuring the **longest or basal shoot** is that one can go to that measurement immediately without delay. It is the most developed of the laterals at any of the levels and so gives us the best informative. It cuts down on the complexity of the entire shoot and makes the whole spray more approachable, reducing the number of extraneous measurements. I recall sitting in a Holiday Inn in Washington DC, all snowed in at 28 inches, and very glad I had two black plastic trash bags full of juniper cuttings from the National Arboretum (with permission of course) to study in my room. I spent two whole days going through all the Gotelli and other cultivars and learning these differences first hand. Between trips across to the street

to McDonalds (the only place open at the time with food), I put the clones side by side and began to notice how the various shoots developed and how they differed.

Leaf divergence vs. Foliar density is an important consideration. An adult, non-divergent, or scale-type needle on a conifer is held close to the stem but a widely divergent, juvenile, or spiny-leaved shoot has longer blades that fill up that space between the secondary and tertiary branchlets. Filled up space equals density at least as we humans perceive it. Because these long, divergent needles also show their stomatal bands in silver much more clearly, juvenile type cultivars tend not only to be denser but paler and brighter in the silvery to blue shades.

I do not believe that cladometrics has been applied so far to the diversity of **Thuja and Platycladus cultivars**. My preliminary observation is that the spacing of the tertiary shoots will be important as well as the distribution of these on the secondary shoots. In some cultivars, it seems there are more tertiaries on the forward or distal side of the spray while in some "ferny" ones that distribution is about equal and the spacing is greater, given more open gap that humans perceive as being "lacy" or elegant.

Much has been written about the **branching angles** and overall **branching architecture** of trees, especially fruiting orchard trees and to a less extent our ornamental shade and street trees. Very often these days a new patented tree will discuss it's range of branch angles, these hopefully being better than previous cultivars in terms of uniformity, ability to fit narrower spaces, ability to handle snow and ice load, anatomical stability, and overall long-term durability. These can be useful taxonomic clues but because trees can be trained and pruned a hundred ways but unknown people at unknown times, finding a mature tree is a risky thing to characterize. For this reason one needs their own plantations of new trees and do absolutely no pruning from the day of grafting until the time of taxonomic measurement. This makes buying nursery stock (likely trained, pruned, disbudded and more!) a difficult thing for accurate branching analysis. It can be done but graft and maintain your own stock with perfect records. When dealing with herbaceous greenhouse crops, branching analysis gets more complex than trianing, pruning, and disbudding. It can also involve chemical pinching agents and other hormones to regulate growth in an artificial manner.

When working with woody plants of various growth rates determined mostly by genetics including...

1. miniature/pygmy
2. dwarf
3. slow/compact to intermediate
4. full/species type vigor
5. atypical high vigor

...it is often good to measure **Annual Growth Increment (AGI)**, the yearly elongation of one single shoot, as well as **Internodal Distance (ID)**, also called internode length or internode spacing. The first measures how much the cultivar grows on average in a range in a full year and this must be established by a certain date as some species grow quite endlessly and other do not. July 15 is safe date for AGI measurements in many areas but not all. Internodal Distance or ID is a measure between the branching or bud nodes on the stem. It seems to be more interesting in deciduous woody plants than in conifers but measurement of both are possible. If a species has an average ID of 5cm and it's dwarf clones 1cm and 3cm, respectively, you have a small basis for taxonomic identification and calibration if those are the only differences. Typically however, dwarf or slower clones have smaller lamina (leaf blades), sometimes more textured and irregularly shaped ones, and often thicker twigs. Measure it all and you'll be fine. Because both AGI and ID are matters of plant culture and thus physiology, they are used in studies of plant fertilization, hormone development, and other

fields. The taxonomist should try to standardize his or her measurements by using a common plant culture on a single site when possible. These values obvious decrease with lower levels of fertilization (expecially nitrogen) and drought stress. They will often increase with high nitrogen, regular watering, and shade.

If one is dealing with **Picea abies mutations** in the form of named cultivars the values and group delimitation might be as follows. If you are grouping cultivars by ID you might do well to include height of the plant at 10 years.

1. miniature/pygmy (**0.5-1.0cm**)
2. dwarf (**1.1-4.0cm**)
3. slow/compact to intermediate (**4.1-6.0cm**)
4. full/species type vigor (**6.1-12cm**)
5. atypical high vigor (**12.1+ cm**)

Cladometrics are very much a taxonomic and academic art and science but I found this approach taken with some effectiveness in the Canadian Plant Patents for a new Thuja occidentalis introduction. This is a just a start.

Comparison tables for 'Anna van Vloten' with reference variety 'Golden Globe'

Length of branchlet of first order (cm)

	'Anna van Vloten'	'Golden Globe'
mean	5.8	4.8
std. deviation	0.36	0.60

Width of branchlet of first order (cm)

	'Anna van Vloten'	'Golden Globe'
mean	6.2	4.2
std. deviation	0.92	0.34

Leaf length (mm)

	'Anna van Vloten'	'Golden Globe'
mean	3.1	2.4
std. deviation	0.23	0.22

Main colour of leaf in spring (RHS)

	'Anna van Vloten'	'Golden Globe'
outer side	10A-C with 165B tip	10A-C with 12B near apex and close to 167B tip

Colour of leaf from upper part of outermost branches in summer (RHS)

	'Anna van Vloten'	'Golden Globe'
outer side	13B with 10C apex	13A-B with 10C apex

Colour of leaf from lower part of outermost branches in summer (RHS)

	'Anna van Vloten'	'Golden Globe'

outer side	11A-B	13A-B
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Colour of leaf from inner part of branches in summer (RHS)

	'Anna van Vloten'	'Golden Globe'
outer side	144B to 143C	144B to 143C

What's the best way to collect and store field data from biometric studies? Since time immemorial researchers have used little **notepads** and **clipboards**, usually the later having some kind of **specialized data form** they created to format and classify data. Often one person measures and another records if you have such a luxury. About forty years people went to **voice recorders** ranging from the old cassette recorder to small handheld devices. One trouble with voice recorder is that tape or memory failure can cause data to be without context such as missing a cultivar name or plot number. These can work well but you might run out of space and you can't record well in a rainy or wet environment. I've been in a wet greenhouse using paper covered in plastic and the old Sharpie to keep the ink from running. Don't want to lose all your data when a sprinkler or irrigation system kicks in! Of course now there are good voice recorders on our **smart phones**. But suppose you need to collect data from a harvest and do it all in one long 12-15 hour day? Phones are not too great for this kind of duration. Most researchers I know while do a few hours of data collection, do a download to a laptop, and charge up the phone for more work. Phone apps can include **Excel mobile app** and **Google Sheets mobile app** if you want something that converts well to a PC or Mac application on a larger computer. There are also **mobile analytics tools** which allow data input and analysis from a tablet or phone. Under the category of **Data Entry** on most phone app sites you will find other tools which might be easier than a traditional spreadsheet. There are firms who do **agriculture and horticultural apps** for specific data entry needs. Some of these could be adapted to taxonomic use.

Are Plant Identification Phone Apps any good? The few I have tried are let downs. A newer one called PlantSnap (www.plantsnap.com) shows more promise and claims to have a database of 600,000 plant samples and 250 million reference images. It claims 90% accuracy to the species or genus level. Not sure about the mushroom species ID being a good idea though, surely not at 90%. Best of all, it gives you some choices if you want to view some suggested taxa. If the results don't work you can save an image to their experts. PlantSnap has an agreement with the American Public Garden Association (APGA), has had \$3.6 million in revenue (2018), and a reported \$34 million stock valuation so this is no casual toy.

I am convinced the future of such **ID apps** will be specialized apps written by experts in a specific genus or species of ornamental plants using off-the-shelf **object recognition software**, it's algorithms and learning from your own image database. Do we wanted yet more pooled ignorance from the internet with people posting Petunias as Geraniums and the software taking that for gospel truth. No, we want experts to select and regulate the standardized images.

CHAPTER THREE

TRADEMARKS IN NOMENCLATURE

The subjects of trademarks in ornamentals nomenclature is a controversial one but one like plant patents/PBR loaded full of legalities, high revenue streams, and commercial drive. They are not going away.

The correct use of trademarks is set down in the laws of individual nations and groups of nations. Trademarks are not taxa but products which may or may not have a taxonomic equivalence. More on that later.

[Name that Plant - The Misuse of Trademarks of Horticulture](#) by Tony Avent is a widely read, alternative view on the subject and is loaded with real-life examples of things grown wrong.

So complex and frankly insane was the nature of trademarks in real life cultivar cataloging, the **Open Registration Of Cultivars (OROC)** project had to develop a set of rules called Principle 20 to handle the various situations with clarity and fairness. [OROC Book VIII](#) has the whole set of principles with examples at the end of the volume. It deals with the **Trademarked Entity (TE)** (a potential taxa or not) through an evaluation called **Taxonomic Equivalency or Association (TEA)**. In general, if the Trademarked Entity is applied across more than one set of unrelated genera it is considered a **Multi-Generic Marketing Brand (MGMB)** and thus not a nomenclatural unit or taxon of any kind. A Trademarked Entity may also serve, and often does, as the taxonomic equivalent of a cultivar or cultivar group in a one-to-one, exclusive pairing or match. The OROC Principle 20 also covered cases where 1) a second author uses an unregistered trademark in possible confusion with another author's use of the name, 2) a trademark name is applied to an established, existing cultivar with the author of the name not being its originator, 3) multiple levels of trademarks such as a trademarked clone within a trademarked cultivar group, and 4) trademark-to-cultivar and cultivar-to-trademarks conversions, especially after a cultivar name is established as a patent or in literature.

Forget the link, I'm putting the entire OROC principles here.

Principle 20. Trademark Name Policy

Principle 20.A. Sensible cultivar name policy. We will seek the registration of sensible, easily read, and communicated cultivar names in natural, vernacular language at all times, discouraging the use of trademarked names as the sole, preferred, logical, or *de facto* name of any garden taxon. OROC Certified Registrars will be asked to coach registrants towards this end, giving them options and suggestions at every step of the process, and doing so within our 24 hours response time window.

- 20.A. 1. A **Trademarked Entity (TE)** is an alleged plant marketing group, taxon, clone, strain, or other unit of naming or designation formed by a species or genus name followed directly by a trademarked name, registered or unregistered, and associated for commercial purposes with it by the originator, nominant, or introducer. For example, *Plantus communis* MORNING SUN® and MAGIC GARDEN™ are both initially considered a Trademarked Entity or TE until it is evaluated by OROC under Principle 20.C.1 for potential establishment of a Taxonomic Equivalency or Association (TEA). Further, the TE once considered for TEA status is further assigned a type of TEA status such as being as defined under Principle C.1.5.1. For example, *Plantus communis* MORNING SUN® is only associated with a single named cultivar 'Golden Ray' and is assigned Cultivar Equivalent (CE) status. *Plantus communis* MAGIC GARDEN™ has more than one clone but also includes cultivars in several unrelated families, namely in the hypothetical species *Florus albus* MAGIC GARDEN™ 'Snowball', *Liana maxima* MAGIC GARDEN™ 'Delicate Charm', and *Arborea erecta* var. *americana* MAGIC GARDEN™ 'Emerald Pillar'. MAGIC GARDEN™ will not be registered by OROC and considered a Multi-Generic Marketing Brand (MGMB) under Principle 20.C.1.1.
- 20.A.1.A. A cultivar and other taxa of botanical nature are defined by the two major nomenclatural codes and the definitions contained there are adopted here.

Principle 20.B. Cultivar-less garden varieties: trademarked entities without a designated cultivar name. While cultivar-less garden taxa are discouraged, we believe as citizens of a free and open world in the right of commercial parties towards using unregistered trademark names as the sole name for a named commercial clone without use of any cultivar name if they so desire for personal or business reasons. However, this practice will be discouraged if

communication is sought with the OROC program.

Principle 20.C. Rejection and modification of some trademark names for logical, practical, and fair reasons.

While OROC cannot determine the merits, validity, or legal status of any trademark, we have chosen to reject some trademark applications for purposes our registration documents.. Reasons for rejection include:

- **20.C.1. Failure to establish Taxonomic Equivalency or Association (TEA) within a single species or single genus** where the trademarked entity has no taxonomic or genetic analog, homologue, direct pairing, or association such as with a cultivar itself, Cultivar Group, botanical form, botanical variety, subspecies, another infraspecific taxon, Grex, Provenance, Gene Group, Hybrid Group, Diversity Group, Genomic Group, Gene Sequence, or Strain_ A trademark entity accepted by OROC should have a one-to-one exact synonymy (even as a clone) with a named taxon such as a cultivar or belong as variable entity to one of the above types of taxonomic or genetic groups as member. It must be identical to a unit of classification or clearly a part of it as known variation. It may be clonally or genetical identical or just be a related member of the group as defined by taxonomists and geneticists, fitting within the defined classification or set of traits. Association can be defined broadly as membership or kinship, phenotypical or genotypic in nature.
 - **20.C. 1.1. A trademarked entity which spans more than one genus is not accepted and will be considered for our OROC purposes a Multi-Generic Marketing Brand (MGMB)** or MGMB name and not a Taxonomic Equivalent or Association (TEA), whether or not it is legally registered for a specific genus or not. Many of these names are registered with authorities for more than one genus even though initially applied to just one. OROC will judge their merits based on actual trade application to one or more genera. The trademark name can be rejected based on the registered trademark's application showing intent to apply it to more than one genus, rule 20.C.1.2 as one exception.
 - **20.C.1.2. Exceptions granted for split, closely allied genera or intergenetic crosses.** Where a genus has been split from another and historically closed related to it (perhaps former Subgenera or Sections), the trademark name may be allowed to span these closely related genera, whether than trademark was established before widespread acceptance of the split or not. In the case of hybrids among closely related genera, exceptions may be granted on an individual basis. For example, OROC would now accept a trademarked entity which spans various new taxa within the complex called Cupressus, Chamaecyparis, Xanthocyparis, x Cupressocyparis, x Cuprocyparis, Callitropsis, and allowing them to cover whatever species names are now preferred.
 - **20.C.1.3. Botanical taxa with selected wild-to-garden horticultural clones accepted as equivalencies.** The above statement 20.C.1 does not imply we recommend botanical taxa such as formae, varieties, or subspecies be distributed or cloned (without unique traits stated) and considered for trademark names in the future. We do understand that collectors, nurserymen, and academic experts alike select heavily from wild populations and select superior clones of these taxa. Let us consider the hypothetical species *Plantus roseus* which normally has pink corollas but with f. *albus* has white to cream ones. Nurseryman John Doe has studied extensively of that white-flowered form around the country, searching out noble wild clones, and selected two of them he calls KENTUCKY CREAM™ and EARLY SNOWFALL™ without any defined cultivar names at this point in time. They are not equivalents of any true cultivar group (there is no valid 'Albus' nor Albus Group) since the white-petaled variants are technical f. *albus*, a wild even if rare entity. OROC would accept these in the form of *Plantus roseus* f. *albus* KENTUCKY WHITE™ as they can be established from a known, perhaps single gene mutation that appears here and there over time in the wild. The originator of the trademark names bears all responsibility to document in specific detail with numbers how his trademarked

clones differs from the typical form. See below for the BVA and BFA terminology.

- 20.C.1.4. **Geneticist's classifications accepted as Taxonomic Equivalencies or Associations (TEA) for trademark registration purposes.** These may be termed genome clusters, hybrid groups, or even Diversity Groups. For example, if *Plantus albus* and *Plantus chinensis* have often been crossed these elite hybrids crossed yet again to new species *Plantus springeri*, these might have already been known in breeding circles as the AC Group (*albus x chinensis*) and now the ACS ((*albus x chinensis*)*x*(*springeri*)) Group. The term Diversity Group is used for subsections of a genome. They are in fact very much like cultivar groups but sometimes have more of a genomic basis than classic taxonomic one. Geneticists often defined species and hybrids groups very differently than even the modern taxonomist. In our very complex times with genes moving everywhere, geneticists are often defining their taxa in very different terms and these are increasing important for landscape and ornamental horticulture around the globe.
- 20.C.1.5. **Trademarks and their Taxonomic Equivalents and Associations (TEA) may be further classified** for speed of registration and communication:
 - 20.C.1.5.1. **Trademarked entity is always just one taxon, in an exact, one to one relationship.**
 - **Cultivar Equivalent (CE)** - this is a one-to-one direct connection between the trademarked name in all cases and one specific cultivar. This means the trademarked name has only one application and that to one specific cultivar or clone. There will be no other variations except when a different trademarked name is presented. The cultivar may be a seed strain and thus more variable than monoclonal material. For example, SUMMER GLORY® is always the same as cultivar 'Sumglo' and there are no other clones of it under different cultivar names. The one-to-one link is precise, exact, and defined.
 - **Lack of a cultivar name.** A trademarked entity may be considered a CE without an actual, known, or published cultivar name. For example, if the originator said he grafted this clone from one sport in his nursery, we consider this to be a monoclonal, cultivar-like or CE situation.
 - **Clarification of propagation method.** When possible OROC Certified Registrars will determine if the trademarked entity is propagated by seedage, cuttage, graftage (Liberty Hyde Bailey's terms) or by tissue culture. Further, if the trademarked entity/cultivar is vegetatively propagated we will ask if it is **monoclonal** (one specific original plant) or **polyclonal** such as a group or similar seedlings or from stock plants which came are variable to hold generally true to the description.
 - **If an originator subsequently introduces additional clones or taxonomic entities in the CE** for what was once a direct, one-to-one association, the position of CGA (Cultivar Group Associate) will be assigned to the trademark name and the originator asked to create very distinct nomenclature to separate the various new taxa.
 - 20.C.1.5.2. **Trademark is part of a larger, variable group, and not one precise taxon, not one-to-one:**
 - **Cultivar Group Associate (CGA)** - the trademarked name applies to more than one defined cultivar or clone such as RED, WHITE, and PINK clones within the trademarked name. There does not have to exist a Cultivar Group in existing literature or registers for the CGE to apply. For example, SUMMER GLORY® is presented by two clones called 'Sunglo1' and 'Sumglo2' also known as SUMMER GLORY® ORANGE and SUMMER GLORY® SCARLET, respectively. The trademark name groups the two cultivars and perhaps future ones in the same manner as a

traditional Cultivar Group. SUMMER GLORY® may belong to an existing Cultivar Group called Rubrus Group for red to orange-flowered variants or it may not have such an existing association. It stands on its own if necessary.

- **If an originator of a trademarked name cannot determine the species affinity of a stock** OROC will assume the new entity is a CE or CGA within the genus only based on the number of distinct entities or taxa claimed or planned for introduction. OROC will provide all means of taxonomic assistance including study of living, pressed, or image material using all resources available to assist the registrant in a taxonomic profile of their taxon or taxa.
 - **If the originator cannot determine the genus of the trademarked entity** it will be rejected until that issue is resolved. Assistance will be provided by OROC at our expense in most cases.
- **Trademarked entities which span several known cultivars groups, botanical formae, or most other infraspecific taxa within the genus** are accepted as a *de facto* **New Cultivar Group Associate (NCGA)**. A good example is a number of cultivars and trademarks of *Campsis radicans* which span f. *flava* (yellow, gold, and orange corolla) and the more typical red to scarlet f. *radicans*. They cannot be said as a trademarked entity to have one BFA or Botanical Forma Associate role. Then they are placed in the role of a Cultivar Group Associate (CGA) or now NCGA on the basis of their origin and shared traits (other than corolla color), forming what is essentially a new cultivar group. Modern cultivars and their trademarked entities span a wide range of genetics within a genus such as dwarfness, corolla color, leaf shape, and perhaps the traits of a specific famous cultivar. One has no need to look further than *Fagus sylvatica* to find weeping purple (f. *pendula* and f. *atropurpurea*), columnar gold (f. *zlatia* and f. *fastigiata*), and weeping purple oak-leaved (f. *pendula*, f. *heterophylla*, and f. *atropurpurea*) clones in the mix which draw from various interspecific groups and their curious genetics.
- **Hybrid Group Associate (HGA)** - these may be defined in various ways by geneticists for OROC purposes we have selected to define this one term. The HGE applies to a specific set of species within a genus crossed with a specific parentage or pedigree whether or not a botanical hybrid species exists or not. There may be two, three, or more species in this known hybrid group. For example, *Plantus communis* x *Plantus vulgaris* may be known botanically as *Plantus* x *intermedius* and trademark of cross would be known as the HGA of P x *intermedius*. A breeder comes along and makes spectacular results by crossing *Plantus* x *intermedius* x *Plantus sinensis* from Asia and calls this the (CSV Hybrid Group) for the three specific epithets of the contributing species, set down in alphabetical order. Her SKY MASTER® series of hybrids including SKY MASTER® CROWN and SKY MASTER® RADIANCE have an HGA with the (CSV Hybrid Group).
 - **Formation of HGA names** has long been a subject of our work within the Cultivars of Woody Plants encyclopedia system. Lacking their definition in literature and establishment there, Cultivars of Woody Plants has established a **system of alphabetical order by specific epithet when grouping interspecific hybrids**. For example, a cross of *Plantus vulgaris* and *Plantus albus* would be called the (AB Hybrid Group) and not (VA Hybrid Group) because *albus* comes before *vulgaris* in alphabetical order. Because male and female parentage is likely to shift from one species to another, there is no harm in this system and it offers many advantages. The *albus* groups of hybrids appear together and in order such as crosses to *Plantus bicolor*, *P. chinensis*, *P. communis*, *P. incisa*, *P. roseus*,

and *P. vulgaris*. If *Plantus* (AB Hybrid Group) x *P. chinensis* occurs with more than one named clone, a logical (ABC Hybrid Group) name will be used to group both cultivars and trademarked entities in future. If *Plantus albus* x *Plantus vulgaris* were already well established in the literature under the hybrid species name *Plantus x smithii*, the cultivar and trademarked entities would be grouped under that name instead.

- **Botanical Forma Associate (BFA)** - a clear member of a botanical form or f. In modern terms, botanical formae are frequently single gene mutations or groups of mutation which alter just one trait such as corolla color, leaf shape, leaf color, fruit color, or leaf shape.
- **Botanical Variety Associate (BVA)** - two good examples would be *Cornus kousa* var. *chinensis* and *Viburnum plicatum* var. *tomentosum*.
- **Genetic Group Associate (GCA)** - a clear member of an established genetic group as a Diversity Group, genomic unit of any name or kind, mutation name (ie. AAaa=double white flowers), Hybrid Group, genomic cluster, or other terms favored by plant breeders in the interspecific and infraspecific classification of variation.

- **20.C.2. The Cultivar Non-Connection Rule (CNCR) : the trademark holder or creator has appended their trademark to an existing, established cultivar** with which they have no connection as originator, introducer, nominant, licensee, legal representative, exclusive distributor (as cultivar), or legal representative of same such as the estate of the originator. In such cases taxonomic equivalency is usually established and clear. Cases of appending trademark names to a cultivar established by other parties over 50 and even 100 years ago are known. For example, *Cotoneaster horizontalis* 'Variegatus' is marketed as NORTHERN BORDERS™ even though this taxon was established in the late 1800's by completely different parties **and** there is no claimed clonal difference. For our OROC purposes, the originator will be asked to create an entirely new cultivar name without documented differences between it and the established cultivars if any differences are claimed before the trademark equivalency can be evaluated. Lacking such a rule, we believe it is open season on all existing cultivar names to be given marketing names that falsely suggest they are new, improved, or otherwise special novelty creations. Registrants will be given opportunity to establish permission from the originator of the old cultivar, including their estates in law and relatives.

- 20.C.2.1. **Rejection of trademarks applied to other, long-established taxa other than cultivars.** OROC will reject trademark names unless registered by an official government unit if they are long established in literature, trade catalogs, or other respected, well-distributed publications and determined to be document creations as new by a specific originator. Recently we saw *Pinus sylvestris* FRENCH BLUE™ as a trademark when the French Blue Strain is very old, respected provenience with some morphological and physiological distinctions. The party who used this trademark had no basis for claiming the strain as their own or doing any unique clones from it (which would require new, distinct names) so we could not accept that name as such.
- 20.C.2.2. **Cultivar groups and certain other ranks established in literature are are not convertible to trademark names** in their exact form if validly or popularly established in literature and well-known documents for a genus. A distinct clone with a trademarked name may be named under a cultivar group such as *Plantus viridis* (Pendula Group) 'Yosemite Falls' but not as *Plantus viridis* PENDULA™ YOSEMITE FALLS if the 'Pendula' or Pendula Group was already known and accepted. Legally, the nominant or namer of trademark name has no restrictions based on the historical record of cultivar or cultivar group names but in OROC we respect this long history and wish to remove potential confusions, distractions, and nomenclatural

disrespect before it occurs. We respect equivalencies and derivations there from but not reappropriation of names to the commercial side which will lead to problems of many kinds in commerce and science.

- **20.C.3. Trademark-to-cultivar and cultivar-to-trademark conversions: prior legal establishment of the same exact name in a legal or official government document as a cultivar** will exclude the trademark from status and registration. For example, if an originator patents a cultivar called 'Golden Queen' in the US Plant Patent system and it is accepted and they thereafter market it as GOLDEN QUEEN™ 'Jonesgold', the cultivar to trademark conversion will be rejected. 'Jonesgold' becomes a later homonym under ICNCP rules. The originator would be free to use GOLD QUEEN™ 'Golden Queen' pair as they are not the exact same phrase. OROC recommends cultivar names not be too close to the trademark to prevent confusion.
 - **20.C.3.1. Use of cultivar name as a trademark in non-legal, official media not approved by the originator or legal representative of the taxon** such as published by a nurseryman, author, or distributor does not in any remove legitimacy of the names as the originator and legal representatives intended or intends to designate them in the future. Legal publication is defined as the trademark, patent, plant breeders rights, or similar governmental agency document (including state universities and agricultural stations producing cultivar releases) which publishes official journals, databases, or registers. Valid publication by authors or cultivar registers is not a basis of legal establishment of a trademark status as such have no jurisdiction over that naming convention. OROC's authority similarly stems only from our acceptance or rejection of a trademark for purposes of assigning a registration number and inclusion in our publications. For example, Juniperus horizontalis LIMEGLOW™ 'Noslg' was published for a very popular chartreuse, lime, and winter purple and bronze sport of 'Youngstown' in Garden Junipers by originator Larry Hatch. It was first published by Humphrey Welch in The Conifer Manual as cultivar 'Limeglow' based on correspondence that I had with him but not with my permission as a cultivar designation. He went print when in those days conifer cultivars were generally outside the trademark realm, making his cultivar ranks assumption logical but not cleared with the me. The first official distribution of this clone assisted by Dr. J.C. Raulston was through the Iseli Nursery or Boring, Oregon and it is still sold by them under the correct name of LIMEGLOW™ while many growers outside that network continue to use the incorrect cultivar designation, especially in Europe. Some nurseryman and authors "jump the gun" and publish names without full knowledge of the originator's desired or final intent.
 - **20.C.3.2. Once a cultivar always a cultivar - Once a trademark always a trademark** is the universal principle of OROC trademark acceptance. Conversion from one realm to the other requires a complex discussion of history in a manner that is logical, legal, and fair. We have a process so please email if you wish to go through the maze, a fair, logical maze at that.
- **20.C.4. ICNCP naming rules are not applied to trademark names** and cannot be the basis for the rejection of a trademark name as the International Society for Horticultural Science has no jurisdiction or legal standing in the naming of trademarks.
 - **20.C.4.1 Protected, inadvisable trademark names.** OROC Certified Registrars are asked whenever possible to alert registrants to possible issues concerning their plant name, especially if it might violate trademark laws known to us and use the name and terms protected worldwide. Please consult an attorney on record if you have any questions as to the legality or wise use of any name based on popular companies, products, or services. Please see your local trademark authority's website for guidelines on the range of products to which you name might be applied and in which countries. A plant using the trademarked name identical or similar to a popular soda, cartoon character, music star, food stuff, automobile, store, or vendor will likely have trouble if that original trademark is broadly based, covering many categories of product and

service. Since an unregistered trademark holder does not go through the registration process, they may not be aware of the extensive coverage of an existing trademark and that it may well apply to their plant, inviting expensive and time-consuming litigation.

- **20.C.5. Promotion of a resurgence of Latin named garden plants.** Latin is a beautiful language and especially botanical Latin. Many plant originators, young and old alike, mourn the day when Latin was banned in cultivar names; that being January 1, 1959. Trademark names have no such restrictions and the name game is wide open now. This new found freedom allows an originator to name a plant in Latin as one example such as HATCHII GLAUCA NANA™ 'Hatch's Blue Dwarf'. Maybe we could get more expressive and turn the ordinary 'Golden Queen' into it equivalency of ELEGANTISSIMA AUREA REGINA™. While OROC will continue to reject and hope to correct Latin cultivar names when submitted, we are offering the alternative of unregistered trademarks for those who wish a bit of ancient class to shine on their new plant creation. OROC is committed to given all plant originators a full range of freedom, options, and clarity when naming their fine new plants. Latin expression is just one way we go. As registration bodies like OROC published registered of trademarks, the reuse of Latinized names will be increasingly unlikely.
 - **20.C.5. Requested and reasonal conversion of Latin cultivar name proposals to unregistered trademark status.** OROC has received to date two cultivar name registrations were partly Latin and the originator was unwilling to vernacularize them. Frankly they sounded more interesting and elegant on the tonque. We encouraged them to designate these new monoclonal as unregistered trademarks and add a true, vernacular cultivar name as reasonable compromise. One declined and the other has agreed.
- **20.C.6. The trademark name includes exact, established scientific, taxonomic names** such as the Latin or Greek name of a species or genus to which the cultivar belongs. SHINNING COLEUS™ is rejected but SHINNING™ COLEUS is not. Coleus is an established botanical genus name and cannot be trademarked in the plant kingdom. It could as a soft drink, laxative, or drug perhaps. Common names that relate to the same plant are accepted and in many ways trademark names conventiently serve in the creation of popular vernacular names in the trade. Olea europaea 'HIDSHURTLEFF' is sold as WESTERN WEEPING OLIVE™ which does not contain the genus name Olea and is thus accepted as ready common name and good unregistered trademark equivalency. Olive is a common name and nothing about trademark law we know prohibits this.
 - **20.C.6.1. Name Reduction Policy: OROC Advocates trademark names to equal common names or serve as the basis** of a new plant common name whenever possible and feasible. This is a very convenient process because when a plant has a trademarked name, cultivar name, and common name, we already add three names to an already complex cultivar count such as 1050 in Juniperus and more than 1200 in Acer. If we double and sometimes triple on those cultivar counts for these trademarks this is becoming a far too convoluted and entangled nomenclatural platform. If Acer platanoides SILVER SENTRY™ 'Billsilver' becomes known as the Silver Sentry maple or Silver Sentry Norway maple we now have a reduction of names. A number of nurseries already take the trademark name and fashion it to the common name in their online catalog database. This practice is encouraged by OROC.
- **20.C.7. The Unregistered Trademark Usurpation Rule (UTUR): unconnected reappropriation of unregistered trademark names rejected as a trade courtesy.** OROC will politely reject an unregistered trademark name that is reused, reappropriated, falsely claimed, or otherwise usurped without the permission of the originating party of the established unregistered trademark name. We wish to established a higher ethical standard and provide some added protection in the name of fairness, consumer awareness, and trade courtesy. For example, one nursery has established a series of dwarf Buddleia called SUMMER GARDEN CANDY™ with subclones in the same genus called WHITE, BLUE, and VIOLET. None are patented. Another, unconnected

grower in another region created and now sells SUMMER GARDEN CANDY™ LAVENDER without permission of the first grower and originator of the name SUMMER GARDEN CANDY™; in essence stealing from his unprotected brand name and gained marketing reputation. Yes we know that the originator of SUMMER GARDEN CANDY™ has no general legal rights (see your own lawyers folks for exceptions as they are good at) to prevent anyone else from attaching to this name and using it at will. OROC will reject the name given without permission as a trade courtesy to avoid confusions and the generally undesirable, selfish behavior on the part of members of the ornamental plant community which is generally respectful, sharing, and kind.

- 20.C.7.1. Applicants will be given the opportunity to present documentation that verifies their permission to use the name and we note any correspondance or legal documents on file with us.
- 20.C.7.2. **Registered trademarks are legally protected from this kind of nomenclatural poaching** but an unregistered one is not.
- 20.C.8. **Simple language translations of the cultivar name** such as Plantus albus LA NIEVE™ 'Snow', the trademark phrase being a Spanish term for snow. It is very likely that 'Snow' will be sold in Spanish speaking countries as 'La Neive' anyhow.
- 20.C.9. **Rejection of simply adjectives as unregistered trademarked entities** much in the manner of ICNCP cultivar rule. OROC has seen some examples where names in form of MAJESTIC® RED™ or MAJESTIC® WHITE™ are being used as an odd combination of registered and unregistered protection. Since RED™ and WHITE™ cannot stand on their own as distinct nomenclatural entities, they are rejected, especially as they could well appear after other registered trademark names in other Cultivar Group equivalencies. OROC would in ths hypothetical example accept distinct TM that follow registered names such as WHITE SATIN™ or RED SIGNAL™. The unregistered trademark name must not be a simple adjective, easily confused, or already used in the genus as trademark, cultivar, or common name.
 - 20.C.9.1. **Rejection of simple cultivar name adjectives appended to rejected trademarked names.** For example, MAJESTIC® is registered in the US and the subclones are sold as MAJESTIC® 'Red' and MAJESTIC® 'White'. The named 'Red' and 'White' have no standing as cultivar names any more than RED™ and WHITE™ as trademarks. The best use of this registered name would be MAJESTIC® RED not MAJESTIC® 'Red' nor MAJESTIC® RED™. The terminal epithet needs no protection because it means nothing without the leading, protected, registered or unregistrered word. The leading registered trademark name must be respected and honored regardless of what terms or names follow it.
 - 20.C.9.2. **Special exceptions at the discretion of OROC Certified Registrars.** We received a name similar to Plantus vulgaris EMERALD™. Emerald is a common term for a range of green colors, gemstone, etc. and perhaps a simple adjective. Or is it? The name had no previous use anywhere in the genus so it was ruled to be acceptable.
 - 20.C.9.3. **OROC will request from the registrant or originator their intended status of Terminal Post-Trademark Epithets (TPTE)** after the tradrmark designation. For example. Plantus roseus JOYFUL SPRING® might be published in various catalog with one clone called JOYFUL SPRING® 'Rosebud', JOYFUL SPRING® ROSEBUD, and also JOYFUL SPRING® ROSEBUD™; the late being the so-called double trademark. Any of these two designation for the terminal phrase is logical and likely legal. It is often unclear with new trademarked entities what status the originator intended as their labels, literature, and those of distributors may show two or all three of these variations. OROC will ask and if necessary explain the different options for the TPTE.
 - The trademarked name coming before the TPTE and directly after the species or genus name is known

as the **Base Trademark (BT)**. If the TPTE is also a trademark also it is known as the **Terminal Trademark (TT)**.

- 20.C.10. **Rejection of trademark names accepted by governmental authorities in error.** Any trademark name granted by governmental authorities which already exists for a botanical or horticultural taxon of the same exact words in the same genus may be rejected on grounds of ignorance of the registering authorities who generally are not plant nomenclature experts not widely consulted with same. OROC will attempt to consult the authorities when feasible but we reserve the right to reject any submitted names for reasons specified in detail.
- 20.C.11. **Any trademark name which is identical in letters, characters, or easily confused** due to 1-3 similar letters with any Latin family, genus, specific epithet, or botanical infraspecific taxon is rejected. This rule is intended to eliminate OROC registration and publication of trademark names based on species or genera and thus a *de facto* analog of it outside the botanical and horticultural naming codes.
- 20.C.12. **A rejected trademark name may still be noted** in ORCC Registers for purposes of historical documentation and promoting clarity but it will always be stated that the trademark name has no registration status and for what reason(s).
- 20.C.13. **OROC reserves the right to reject any trademark or cultivar registration based on deliberate fraud, misrepresentation of data, or falsification of facts.** These include but are not limited to mis-statement of parentage, origin and history, exaggeration of traits, falsified statements on pest and disease testing, renaming an existing clone with no changes or modifications, or permissions in the use of private cultivar or trademarked names. For example, if a breeder stated they have permission of the estate of a well-known political or celebrity figure to use their name and OROC determines by investigation this is not true, the name will be rejected. If a newly named trademarked entity/cultivar is determined by thorough DNA analysis to be identical to an existing clone which may or may not already have legal protection, the name will be marked as REGISTRATION RESCINDED with a full statement of facts. This has happened in several genera where one grower seized upon superior material and calls it their own, mistating both the origins and their role in creating the new taxon.
 - **OROC will demand proof of trademark status if registration is claimed** in some cases. We have found names using the American (R) or ® prior to acceptance at uspto.gov. This is unacceptable fraud and will not be tolerated. We are not a trademark policing organization and it is the responsibility of users of our documents including all OROC Books to do due diligence in their own checking of trademark databases around the world.

Principle 20.D. Valid publication and establishment of existing cultivar and trademark names. OROC Certified Registrars will use their judgement to determine if a cultivar name has been sufficiently established in literature, cultivar registers, trade catalogs, or other available documents when applying these rules relative to trademarks. They will seek advice of colleagues, specific genus experts we have on file, and all available information, publishing their decision guidelines and logic in the OROC Book Registers for the record. The database of all international authorities permitted to issue legal trademarks will also be consulted.

Principle 20.E. Lapse of a registered trademark name protection (LIVE to DEAD in uspto.gov terms) is a growing issue. Growers often listed cultivars with registered trademarks after the legal protection has lapsed one of several reasons that legal protection was removed by a governing body. These lapses are not generally reported in the nomenclatural and nursery communities.

- 20.E.1. **Registered to Unregistered trademark demotion in OROC documents.** If a registered trademark is known to be **DEAD** (bold black letters, uppercase in the US Trademark Office database, uspto.gov) the ® symbol is to be removed and replaced by the ™ symbol, noting when possible the date and reasons for this change in legal status. The USPTO uses an Abandonment Date in their files. OROC cannot maintain immediate, live, real time updates on all plant trademarks so those concerned are advised to study governmental records and

databases themselves should any questions arise. For example, *Viburnum carlesii* SPICE BALL® was registered with US authorities on June 10, 2013 by Spring Meadow Nursery, later show as DEAD with an abandonment date of June 24, 2014. It now is correctly listed by Spring Meadow, Proven Winners, and their distributors as SPICE BALL™ for this reason. Growers are free, pending any legal action to the contrary, to use the unregistered name with or without permission of the originator.

- 20.E.2. **Possibility of registered trademark renewals after a lapse or DEAD status.** It is further possible that a lapse or DEAD registered trademark can be renewed, even after years of no protection, and reestablished in good standing or becoming LIVE. Consider this in your research, label printing, and other documentation.
- 20.E.3. **Possibility of trademark lapse or DEAD status in one country but not all.** Covering the registered trademark status in all countries is a daunting challenge for the thousands of known trademarked plant taxa. If a trademark is stated as DEAD and ALIVE in the United States or another country, it still may have protection in other countries.

Principle 20.F. Standardization of superscripts, fonts, and registration status.

- 20.F.1. **Registered trademarks** are noted like this example: *Plantus communis* REGMARK® 'Cultivar' or alternatively higher as *Plantus communis* REGMARK® 'Cultivar'. The higher superscript format can disrupt the word flow and spacing in some documents.
- 20.F.2. **Unregistered trademarks** are noted like this example: *Plantus communis* REGMARK™ 'Cultivar' or alternatively higher as *Plantus communis* REGMARK™ 'Cultivar'. The higher superscript format can disrupt the word flow and spacing in some documents.
- 20.F.3. **Trademarked names and their terminal names are to be in 100% uppercase** such as *Plantus communis* REGMARK® 'Cultivar' and not *Plantus communis* Regmark® 'Cultivar' nor *Plantus communis* 'Regmark'® .
 - 20.F.3.1 The ™ and ® cannot follow a cultivar name with or without single or double quotation marks. They have no meaning in the context of cultivar nomenclature.
- 20.F.4. **Default unregistered TM status.** In some countries there are trade or PBR names in uppercase which precede a cultivar name such as WINTER GEM 'Joesgem' but no particular superscript is shown by the originator or authorized licensed parties. In conformity with the US system of designations, OROC will assume the use of an unregistered TM unless the originator uses the PBR superfix instead. Unregistered trademarks require no communication with legal, governmental, and official agencies and are automatic merely by publication as such by the originator of any product including plants. The name would be changed to WINTER GEM™ 'Joesgem' under this rule whether published in the US or not. As far as we can determine the PBR superscript has no legal standing in any country to protect a trademarked or registered name.

Principle 20.G. The double trademark is accepted by OROC (except where one name violates 20.C.1. as a Multigeneric Marketing Entity) if both trademarks can be determined to have taxonomic equivalencies. For example, if *Plantus communis* SPRING ROMANCE™ DIAMOND RING™ 'Caret' and SPRING ROMANCE™ WHITE WEDDING™ 'Veil' were the equivalent of a cultivar group (SPRING ROMANCE™) and its specific cultivar clone (either WHITE WEDDING™ or DIAMOND RING™), both trademarks names would be registered. This establishes both CGA and CE status under TEA guidelines. If SPRING ROMANCE™ appeared in more than one genus, it would be considered a Multi-Generic Marketing Entity and stated as such.

- 20.G.1. **The double trademark has four possible variations:** (R)+(R), (R)+(TM), (TM)+(TM), and (TM)+(R) such as GARDEN GLORY® RADIANCE®, GARDEN GLORY® RADIANCE™, GARDEN GLORY™ RADIANCE™, and GARDEN GLORY™ RADIANCE®.
- 20.G.2. The trademarked name used first is known as the **Base Trademark (BT)**. If the TPTE is a trademark also it is known as the **Terminal Trademark (TT)**.

Principle 20.H. Multiple trademark names for a single cultivar name are reluctantly accepted by OROC on the grounds that not all trademark names are legal, sensible, or suitable in every market and a single cultivar may in fact have to have more than one marketing name. For example, Weigela 'Slingo 1' is sold as CRIMSON KISSES™ by Monrovia in the US and as ALL SUMMER RED™ by the originator Vert Berhoef, the lines generally drawn between American and European growers. Likewise, Weigela 'Velda' is offered as TUXEDO™ and also EBONY AND IVORY™. While this practice is to be discouraged for its massive ramifications on making nomenclature more complex and confusing to the consumer, one must respect cultural differences and special situations in each region of the world.

Principle 20.I. Temporary unregistered status as a path to registration and full legal protection. OROC accepts and acknowledges that it is common practice to first sell a new trademarked entity under the unregistered TM while the legal, registration process is ongoing. This very much like a PPAF (Plant Patent Applied For) designation as a temporary bridge to discourage improper use of names and germplasm. Thus the conversion of a name from unregistered to registered is a normal, logical, and important process in the naming of plants and is not to be discouraged nor condemned. It is the obligation of all cultivar registers, authors, taxonomists, and others concerned with proper trademark annotation to keep abreast of the status of applied names for the sake of accuracy in their databases and publications. This is very much a concern for curators who must create or purchase very expensive, permanent metal labels when the ultimate trademark status is uncertain.

Principle 20.J. Nomenclatural role of subscript symbol location in determining rank or status. It is important that all registered trademarks have the (R) symbol appear after the actually registered name and not the unregistered name variants which flow from it. For example, if I were given registration rights to SPRING GLORY® I would perhaps have clones of it called SPRING GLORY® RED, SPRING GLORY® WHITE, and SPRING GLORY® PINK. These would not be legal as SPRING GLORY WHITE® unless that full, three word name were registered on its own with full documentation in the governmental database. Some large, successful growers do go to the added legal and process expense of registering many versions of the base trademark with all the color variations covered. The same does not apply to unregistered trademark names except where rule 20.C.8 applies.

Principle 20.K. Automatic transfer of trademark data when specific name or generic name is changed or corrected. Except by objection of the originator, all accepted trademark and cultivar information is transferred to the correct botanical name of the registered taxon in the event the originator uses an outdated, invalid, or otherwise incorrect name, OROC has accepted a new name for the base taxon, or genus changes for that specific species. This has occurred in the case of trademark cultivars of Myrica becoming members of the genus Morella.

Principle 20.L. Taxonomic Equivalency and Association (TEA) of a trademarked entity will not hinder application of existing cultivar groups or other interspecific ranks within the nomenclatural hierarchy. For example, a breeder creates two lines of hybrids within the species *Plantus communis* called PRAIRIE SNOW™ and PRAIRIE GEM™, respectively. *Plantus communis* f. *albus* PRAIRIE SNOW™ CRYSTAL is the full name of one named clone as it is referable to wild-occurring, white-flowered f. *albus* but by no means represents all the known variation of that botanical form, wild or cultivated. Similarly, *Plantus communis* (Nanus Group) PRAIRIE GEM™ JADE is the full name of another named clone, belonging to the cultivar group Nanus Group, covering all dwarf taxa with the dwarfness gene(s) of old cultivar 'Nanus' from which JADE was bred. The trademarked names here thus serve almost as a subforma (though of no botanical standing) under f. *albus* and as Subcultivar Group under the Nanus Group, forming an even more complex hierarchy of names. Let us take this hypothetical example further to show the integration of botanical, horticultural, and trademarked names, registered or not.

- *Plantus communis*

- o f. albus - the wild, white-flowered form known occasionally throughout North Carolina, Tennessee, and Kentucky, rarely appearing in seed blocks
 - 'Albus' - the common clone of gardens, selected by Smith Nursery 1883
 - 'Albus Superbus' - a larger-flowered selected of the original 'Albus' from Jones Nursery 1901, not widely seen
 - 'Albus Marginatus' - a sport of 'Albus' with a very thin, yellow margin to each leaf
 - 'White Magic' - a popular modern American clone from about 1954
 - PRAIRIE SNOW™ - a new series of white-flowered hybrids from Metropolis State University 1990
 - PRAIRIE SNOW™ CRYSTAL 'MSU01' - a compact, very clear white corolla, dark green leaves
 - PRAIRIE SNOW™ CRYSTAL IMPROVED 'MSU22' - as above but higher fungus resistant, corolla larger to 2.1 in. wide
 - PRAIRIE SNOW™ SNOWBANK 'MSU03' - a large growing form, slightly more creamy-white corolla than CRYSTAL
 - PRAIRIE SNOW™ FLAKE 'MSU17' - a medium-sized form, corolla nearly white, it's lobed slight incised suggesting a snowflake
 - 'Fancy Flake' - a white-margined sport of above, not eligible for use of the other parties trademark name since unrelated in origin.
 - WEDDING DAY® - a new series of hybrids from Gotham City Nursery 1988
 - WEDDING DAY® BRIDE 'Gothbride' - compact, spreading, flowers pure white, larger to 2.2 in. wide
 - WEDDING DAY® GROOM 'Gothgroom' - tall, erect, flowers nearly white, 1.8 in. wide
- o f. roseus
 - 'Roseus' - a polyclonal mix dating to England and France about 1888, very variable in quality and color
 - 'Roseus Grandiflorus' - a selection with the corolla about 1.8-2.0 in. wide
 - 'Roseus Jonesii' - a pale blush corolla, Jones Nursery about 1908, true clone possibly lost
 - 'Pink Queen' - corolla a reliably rich pink color, sometimes washed out to white or blush in full sun
 - ROSE GARDEN® - the darkest pink corolla known, very magenta-red in bud, leaves blackish-green, corolla to 2.3 in. wide
- o f. communis
 - 'Green Magic' - a popular, compact hedge selection, larger than 'Nanus' and much more vigorous
 - 'Variegatus' - leaves irregularly margined white to cream
 - Nanus Group
 - 'Nanus' - 2-3 ft. tall, very dwarf, dense, named by Doe Nursery 1889
 - 'Pygmaeus' - 6-12 in. tall, very slow, tiny, used for bonsai, leaves very tiny at 0.5 in. wide by 1.0 long.
 - PRAIRIE GEM™ - a dwarf set of hybrids from 'Nanus' by Metropolis State University 1996
 - PRAIRIE GEM™ JADE - 1.5-2.0 ft. tall x wide, stays dense without trimming, rich bluish-green foliage
 - PRAIRIE GEM™ EMERALD - 2.0-3.0 ft. tall x wide, about 'Nanus' size but leaves a richer, darker green tone
 - BOWLING BALL® - very dense, globose, smaller leaves, a cross of 'Nanus' x 'Pygmaeus' from Generic Nurseries 2011
 - Salicifolius Group - more, narrowly elliptic to widely linear blades
 - 'Salicifolius' - the original clone from Paris Nurseries, France about 1897, blades 1.2 in. wide x 6 in. long
 - 'Green Spear' - an improved selected clone, blades 1.0 in. wide x 4-6 in. long, a darker green, apex more acuminate, sharp
 - 'Silver Spear' - a white-margined leaf sport of 'Green Spear', origin unknown

After extension study by OROC, it was determined that about 22% of popularly used registered trademarks in the United States system were officially **"Dead" trademarks**, meaning they had lapsed, been rejected, not renewed, and so on. Yet the registered trademark symbol continues to exist in catalogs, literature, and on nursery labels! Thus the cultivar received undue and frankly unlawful protection it does not deserve. In a few cases, lapsed registered trademarks were renewed. <http://tmsearch.uspto.gov/bin/gate.exe?f=searchss&state=4802:173kwn.1.1> is the official website for checking

on any registered mark in the U.S. It has been the policy of OROC to demote or bump down a registered trademark from (R) to (TM) if it's official status is "Dead" in the US system.

The return of Latin and non-vernacular epithets for clones. Some people are not happy about the loss of the beautiful languages of Latin and Greek in naming garden plants. I am one of those sad fans of the old practice. The Cultivated Code clearly bans the use of such non-vernacular epithets for cultivars. But what about trademarks? There are no language bans there save for the word or phrase being in use in the same category. So if we have *Plantus vulgaris* 'White Queen' who could stop it from being called popularly and in big fonts on a label REGALIS ALBUS or CANDIDUS GRANDIFLORUS? No one. I am threatening to name my next creeping juniper as *Juniperus horizontalis* GLAUCUS HATCHII ELEGANS SUPERBISSIMUS ROBUSTUS. Just might happen or I might come to my senses and limit my zeal to HATCHII ELEGANS. There are no Latin names for cultivar, *per se*, but the same clone can be captured in Latin with the trademark work-around.

CHAPTER FOUR

COLORIMETRIC SYSTEMS AND APPLICATIONS

Let's get one fact out of the way first. The best, most professional, reliable, and scientific ways of determining the color of plant parts is a laboratory colorimeter and spectrophotometer. These range from \$600 (used) to more than \$4000. If you are publishing in a peer-reviewed, academic journal they will pretty much expect you to have technology of this grade.

Hunter Labs has an interesting introduction to their products and this topic:

<https://www.hunterlab.com/blog/color-measurement-2/tools-advanced-color-analysis-help-professional-horticulturalists-corner-niche-markets/>

Before going any further take a look at this paper by Donald Voss that spans the garden and laboratory worlds:

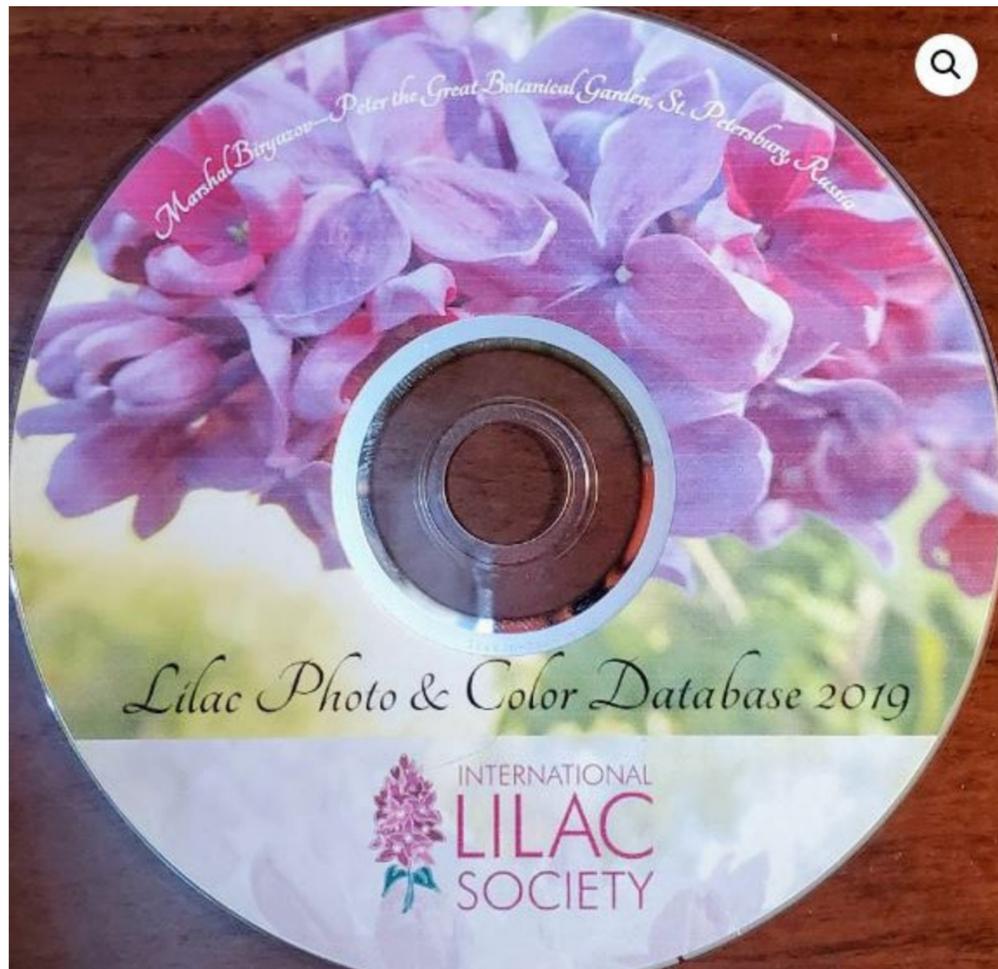
<https://journals.ashs.org/hortsci/view/journals/hortsci/27/12/article-p1256.xml>

Voss, D.H., 1992. Relating colorimeter measurement of plant color to the Royal Horticultural Society Colour Chart. HortScience, 27(12), pp.1256-1260.

He also compares some the version of the RHS system:

<https://journals.ashs.org/downloadpdf/journals/hortsci/33/1/article-p13.pdf>

Voss, D.H. and Hale, W.N., 1998. A comparison of the three editions of the Royal Horticultural Society Colour Chart. HortScience, 33(1), pp.13-17.



Before moving on I want to plug the 2019 International Lilac Society Lilac Photo and Color Database by Dr. Mark L. Debard which contains RGB color values for 1339 different Syringa cultivars, perhaps the most impressive effort to bring practical color terminology to a big range of ornamental garden taxa. Dr. Debard has made a very extensive study of color measurement and like me had sorted it out to a very practical level with works in the real world of cultivar diversity. It is only \$50.00 at <https://www.internationallilacsociety.org/product/ils-lilac-photo-database/>

I have studied color systems applied to ornamental plants for hundreds of hours, walking about with fans, boxes, phones, laptops, and even the same kind of color scanning device a designer uses to match pan colors in your house. While the most widely used system, the **RHS Colour Chart** has frankly two few colors for the reality of our gardens, is overpriced, barely available in many countries, and is too heavy for carrying around. The 6th Edition with 920 colors is too little, too late. As I write this on November 15, 2019 you have to order it from England (no more American Nurseryman book store convenience) and the price is \$290.00 in American money.

If we look at attempts to use the RHS system for complex colors with extreme, subtle, nuanced, or immediate colors tones, it almost always fails or requires a set of awkward measurements that don't due the plant justice. For proof I cite the Diervilla 'Ed Madrigal' patent in the Canadian system. "Redder than" and "redder than....with green colour present". Makes no sense.

Colour of leaf blade in autumn (RHS)

	'El Madrigal'	'SMNSDRSF'
upper side	redder than 200B	redder than 200B with green colour present

The world's leading system for specifying color in industry, architecture, design, printing, branding (including all your favorite sports team), textiles, product molding, cosmetics, and so on is **Pantone**. I picked up their Goe system with 2350 colors for about one hundred US dollars and this simple,

one fan is light enough to put in your pocket and haul around the garden. I tested it out at some gardens including one with 12,000 taxa and only found two plants of more than 500 sampled, a cream-toned Canna with maybe 27 different shades in it and a very bright hardy Gesneriad that was simply a fluorescent orange, that could not be measured with ease.



The day I walked into a garden with thousands of taxa with the above **Pantone Goe Uncoated** fan and 2058 colors my world changed. There was no more unwieldy RHS box and making notes that a color was "darker than", "lighter than", "close to", "intermediate between..", or the common "no match" when recording my data.

One of the first organized products of my Pantone research was the following chart published in my book **The Redbuds**, which is similar to the Cercis file in Cultivars of Woody Plants. I first surveyed the taxa at the huge collection at the J.C. Raulston Arboretum and determined we had 34 different measurable shades. I expected most of the taxa to vary a bit for the Pantone value and they certainly did with some having 5 different values. The most red one was *C. canadensis* 'Pinkbud' and the most plumy dark were 'Oklahoma', 'Don Egolf', 'Kay's Early Hope', pure *C. chinensis*,



What happened when we used a handheld Pantone Cue to measure plants in the field? This was a \$220 investment by the New Ornamentals Society some years ago and we felt it might be a nice way to measure plant colors in the field. It was designed for designers who want to "paint your walls the color of the sofa" or "make a new widget the color of this paint sample". Even with the frequent need for calibration it proved only reliable on flattest and dullest of wide tissue surfaces. A very shiny Ilex cultivar would return either olive green or very blue measurements because of the high reflectance of white and other bright frequencies. Most broadleaf evergreen were hopeless due to their gloss and sometimes texture. A mass of divergent juniper foliage was a total mess and nothing good could be captured. Flowers with wide, flat petals did the best and these mostly over an inch long. A flat Acer or Quercus leaf without too much texture or venation would be give good values too but the smaller-bladed and incised cultivars like Acer palmatum were a mix of good and silly readings. If the chip that appears on the screen (the Pantone color match) does not match what you see in the plant below the device, the results were considered poor to fair. We recorded that 68% of taxa surveyed had a fair to poor color value, making it a not terribly reliable thing. It was an expensive lesson at the same but something potentially so good we just had to try. The Pantone color fans were a full 99% reliable. The device failed but the fans are very efficient and accurate.

The question is now: **who is using Pantone color values professionally and in literature?** I started with a US Plant Patent search and found 140 recent references to "Pantone". The number of patents containing "RHS Colour" or "RHS Color" was 236. I have data from earlier years showing that number being over 500 if older patents are counted. These are rough numbers and the word "RHS" may imply other purposes such as references to their publications or trials. The University of Florida, one of the largest and most prestigious plant breeding programs on the planet, has been using Pantone color values such as their Vaccinium patents. One very detailed example of a Pantone CYML 2014 description is this one for Echeveria 'Andromeda' in the US Plant Patent system:

Color.—Young foliage upper side, middle of leaf: Near S 326-6 Pantone. Some areas of S 327-5 Pantone. Young foliage, upper side, margin near apex: Near S 142-4 Pantone. Young foliage, upper side, margin mid leaf: Near S 148-8 Pantone. Young foliage, under side: Near S 327-7 Pantone; if glaucous layer is removed, near S 329-4 Pantone. Young foliage, under side: Near S 327-7 Pantone; if glaucous layer removed, near S 329-4 Pantone. Mature foliage, upper side: Near S 281-8 Pantone; near S 298-6 Pantone, where glaucous coating

has been removed. Mature foliage upper side, mid leaf: Near S 325-5 Pantone. Mature foliage, apical margin: Near S 121-2 Pantone to S 121-1 Pantone. Mature foliage, under side: Near S 159-15 Pantone & S 159-6 Pantone. Mature foliage, under side, apical margin: Near S 166-3 Pantone. Mature foliage, under side, near stem: Near S 160-11 Pantone. Venation: There is no visual appearance of venation.

What is the best, practical field-based color measuring technique for garden plants? This is purely my opinion but based on over 1000 taxa studied and many thousands of measurements. It involves the use of a modern smart phone with an app than scans the plant with the camera on the phone and measures the values in RGB. I have tested several programs and the very best and most reliable one in called **ON COLOR** from PotatotreeSoft (https://play.google.com/store/apps/details?id=com.potatotree.oncolormeasure&hl=en_US). You can almost effortlessly get 3-10 RGB values of color from a complex flower or just a couple major ones. You simply move the target to the part of the plant desired and viola! Move it again, another color or two. Best of all it gives you reasonable, standardized names for the colors too. Also you can store the plant image with it's color profile for later viewing. I like the **RGB system** because every computer, phone, and tablet on the planet can display these color values. The communication is immediate, accurate, and universal without the purchase of anything than the phone you already have. We use ON COLOR extensively in the International Coleus Society and that a tough genus for complex, subtle colors. All those overlapping bands and spots and such are handled easily with this technique.



This is the **ON COLOR** app on a Samsung Galaxy Note 4 back in the day when both the phone and app came to me. This was Coleus WIZARD® JADE and it obviously had some whitish, cream, and light yellow shades. But there seem to be much complex and odd colors in the center and ON COLOR identified one of them as "Pale Golden Rod" (RGB 243,231,165). Let me communicate that color to you in this file as the following big chip. I'd almost call it beige or a light tan and it's just one of 13 colors that Coleus WIZARD® JADE gave me that day, this one the least obvious until I tried and looked and scanned and recorded it.



The keys to RBG color documentation are:

1. Use the ON COLOR phone app in a normal light. Use the flashlight function if late or early in the day.
2. Every plant part (flower, leaf, stem) will need 3-15 values to be measured accurately. It is a **set of colors** not one color you're trying to get.
3. It's the RGB values a cultivar does NOT have to often separated it out from others
4. Look for healthy, mature tissue so nothing too early in the spring or the tissue's development. Standardize things the best you can.
5. Tag colors by the part of the tissue such as flower throat colors, main petal surface, bud color, fading corolla, calyx mature, etc.
6. Keep a spreadsheet or database with the taxa recorded

FIVE THINGS EVERY ORNAMENTALS TAXONOMIST SHOULD CARRY OR LINK FROM THEIR PHONE:

1. Woody keys from Jan de Langhe:
https://www.arboretumwespelaar.be/EN/Identification_keys_and_illustrations/Identification_keys/
2. ON COLOR to measure any plant color in RGB: https://play.google.com/store/apps/details?id=com.potatotree.oncolormeasure&hl=en_US
3. Your local floras such as: http://www.herbarium.unc.edu/FloraArchives/WeakleyFlora_2015-05-29.pdf
4. PDF monographs with keys such as efloras.org:
<http://flora.huh.harvard.edu/china/mss/volume11/Aceraceae.pdf>
5. RHS Horticultural Database: <https://apps.rhs.org.uk/horticulturaldatabase/>

Very useful in converting RHS values to RGB is this production of the Azalea Society:

<https://www.azaleas.org/rhs-color-fan-1/>

There is one important key to making RBG the best and most reliable color in horticulture: get your video card and monitor calibrating using a tool color calibration. If you view a website with RBG measures or I send you some values from my study, you cannot produce these accurately with an out of spec video and monitor combination. Modern computers are pretty good at arriving and staying calibrated and true to color. But over time a correction may be needed.

One very smart and useful application of RBG value is **The World of Salvia** color charts. Highly recommended and practical work:

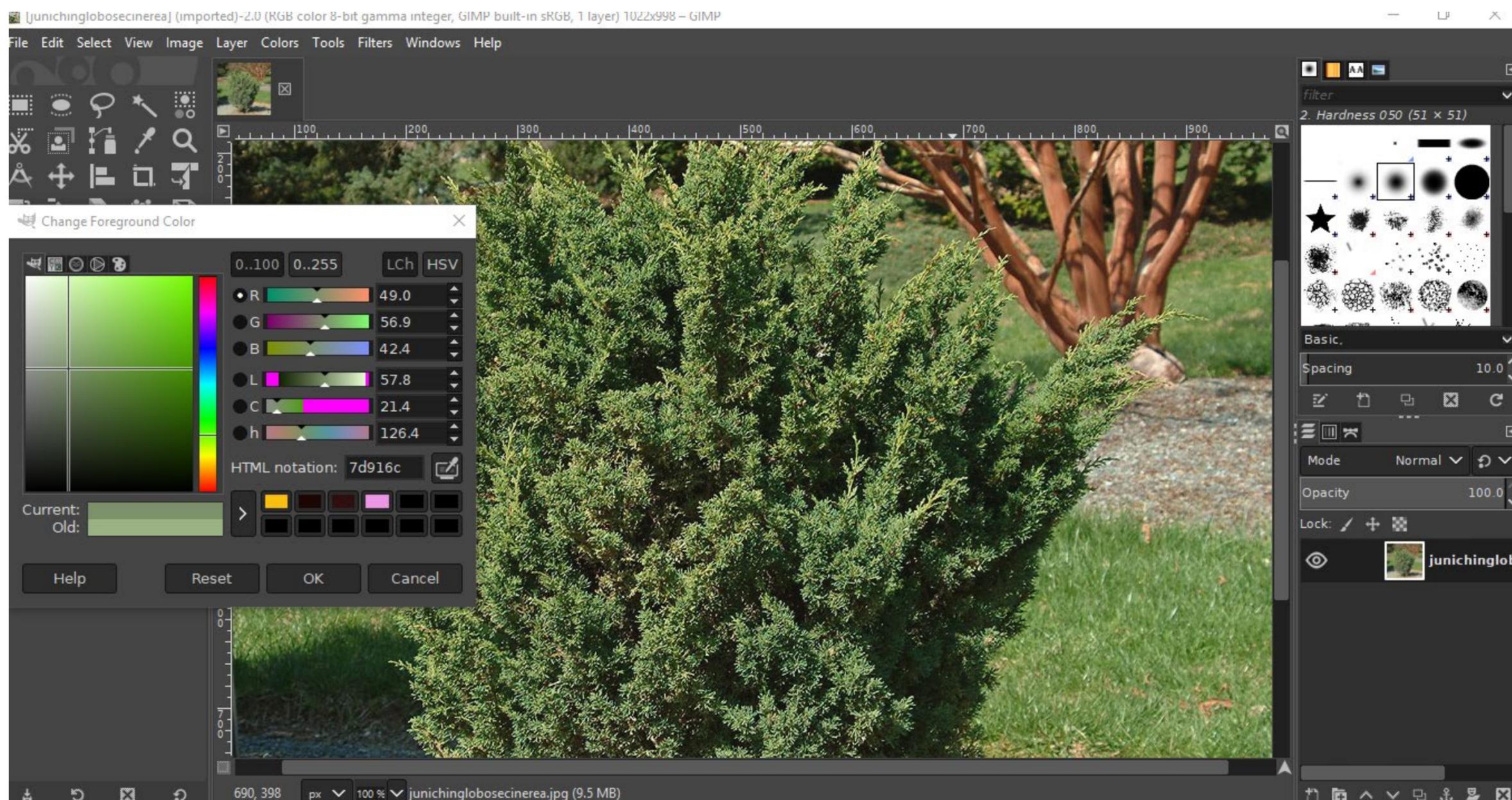
<http://www.worldofsalvias.com/colchts1.htm>

Some plant experts develop their own color systems and the **American Dahlia Society** is one example. I am not sure this is a good direction but this approach does work for them.

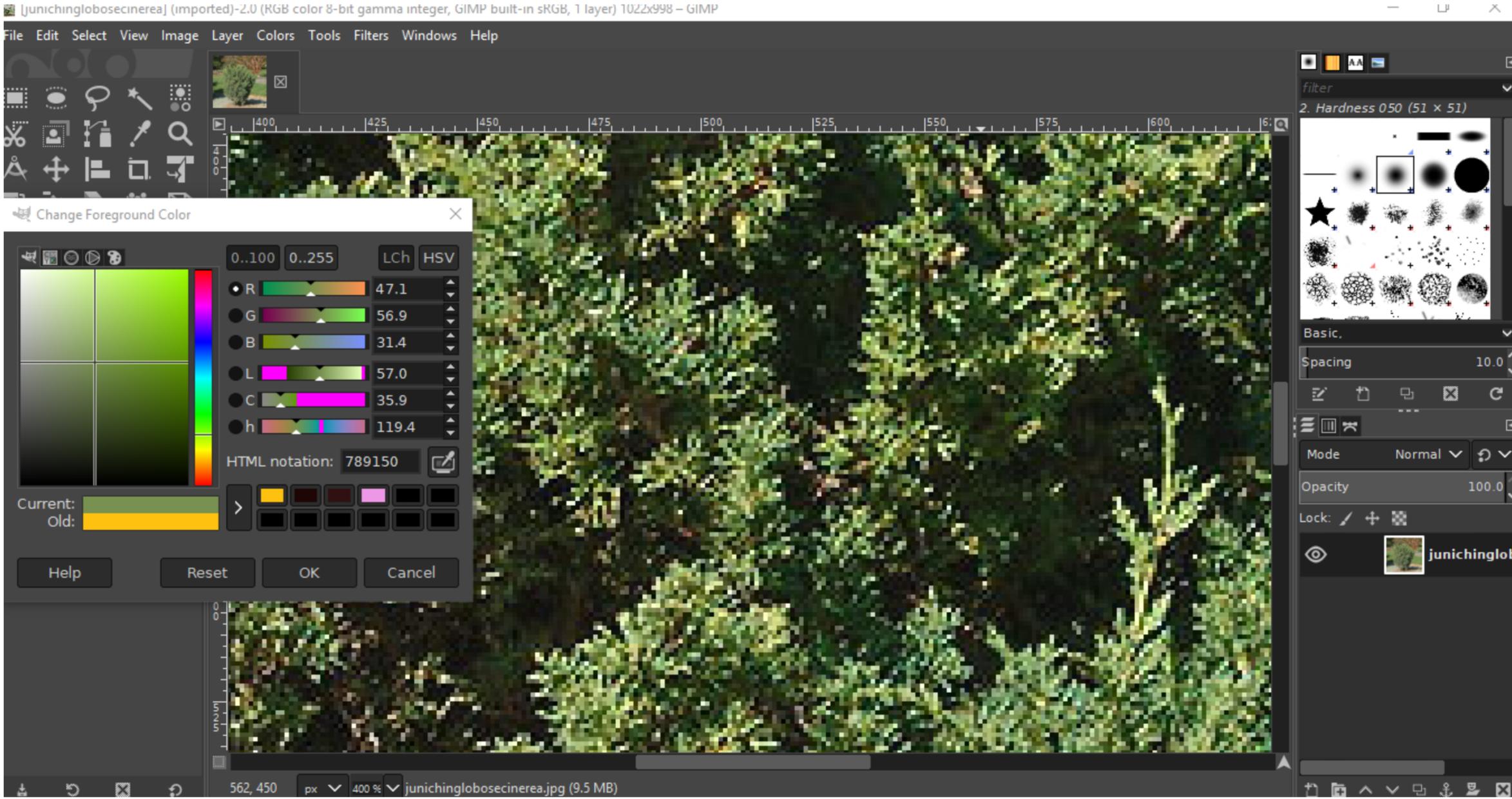
<https://www.dahlia.org/shop/4651/>

The use of hyperpixelation of stored image in color characterization. Most of us who specialize in a group of plants (or twenty!) have a good set of images we find useful in our work. These image are also valuable if care is taken for color determination. Once again, be patient and expect to need 2-10 color values per taxon or sample. Using the **GNU Image Manipulation Program or GIMP** (<https://www.gimp.org/>) software program, essentially a free version of Photoshop that is some ways better and easier, load a plant image and in this case select "Change Foreground Color". This gives you access to the the **eyedropper color sampler** which a large number of paint or graphics programs have.

In this example I used a particularly difficult subject, a conifer and more specifically *Juniperus chinensis* 'Globosa Cinerea' at the Gotelli Collection at USNA in Washington, DC. It's a jumble, a chaotic mix of reflections, shadows, glaucous waxy tones, older leaves with less wax, new more bright tips, and so on. We perceive it and remember it in our heads a nice bluish-gray to greyish-green. This first image gave me a color reading show next to the "Current" box below.



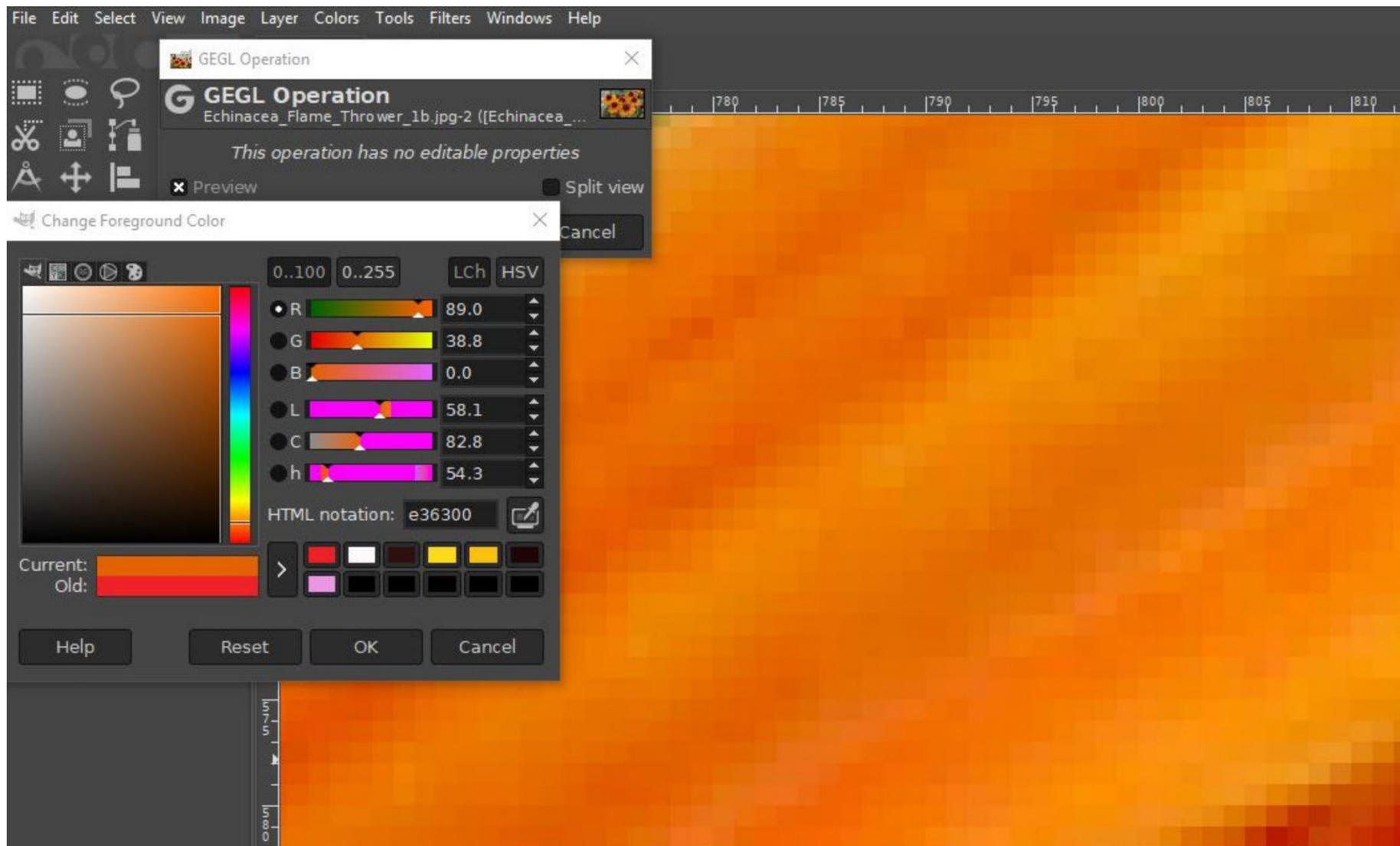
After hyperpixelating the same image in GIMP which is done by going to view and selecting 200-500%, all the individual color components of the overall foliage mass are shown in separate, more easily sampled pixels. I normally skip the inner, darker values because ever plant in the world has older, more shaded foliage close to dark gray and blacks shades. Not too much of value there although a super-dense cultivar will have less of those dark patches. With this hyperpixelated image I can now select 5-10 values that measure the gray to green shades of this cultivar. If I compared this to one of it's nearby relatives *Juniperus chinensis* 'Plumosa Aurea', the values would be very different. If I worked with a more green, less glaucous Chinese juniper cultivar, we'd get a very different set of measurements but probably some overlapp.



Let's look at hyperpixelation in a flower color, this being *Echinacea* 'Flamethrower' in what appears to be a fairly uniform ray flower color except maybe more red at the ray base. The first image below is 100% view or the original image. The second is a narrow magnification done at 1600%.



At this higher mag level I can capture the main part of the ray and you quickly notice the folds or ridges in the ray flower hid many different yellow to orange color values. I would also want to go the ray base and measure that area too. I got 11 RGB values out of the main ray area and I have no doubt you could hunt for even more. It is always good to be thorough but sometimes it is enough to sample only the most dark extremes, light extremes, and some of the middle hues.



NOD Color Syntax II was developed in the 1990's for use in New Ornamentals Databases, using common but standardized color terms. It works for flowers and leaves both, assuming there is a primary color and a secondary color in some pattern. Each color may be described as dark, medium, light or tinged another color. The color syntax has also been modified for specific genera as in the Cultivar.org files Semperfile (Sempervivum and Jovibarba), cvLilium, Glad-db (Gladiolus), and PAULI (Saintpaulia).

The **main syntax** is:

[main color][shade of main color][pattern][secondary color][shade of secondary color]

For example:

red medium mottled pink dark
 red medium mottled pink light
 red dark margined white
 red dark margined white spotted green

Why is it "red dark" and not dark red. This makes search of the first portion of the datafield easier because fcolor="red" finds them all while "red

dark" finds just the darker shades. Modern databases have more search options but in the day the term that began the datafield was always most important and could stand alone without qualifiers.

Some uses of the system **omit the shade** for easier grouping:

green margined white REPLACES green dark margined white, green medium margined white, green light margined white (if the shade of green is considered less important), as white does not have dark, medium, or light versions here. Obviously "green margined yellow" could have three shades of green and three of yellow in various combinations. It needs only to be that specific and complex if you need it to.

The shade terms are optional and may be omitted. Try to be consistent for better, accurate searches.

The **pattern terms** officially used are:

- margined (edged or picotee)
- bar (central stripe as in many Liliium)
- banded
- centered (as in a medio-picta chimera)
- tinged (tints or subtle blend)
- mottled (maculated or speckled)
- tipped (apical zone)
- lined (thin lines)
- striped
- netted (reticulated veins)
- brush (as in Liliium brushstroke markings)
- waxed (as in glaucescent or other wax coating)

The **standardized main color terms** we prefer are as followed but when consistent you may choose your own terms.

- black
- blue
- brown
- cream
- green
- lavender (or lilac)
- orange
- pink
- purple
- red
- silver
- violet

- yellow (gold)

Because of the tinged pattern, other colors can be constructed with ease when colors blend.

chartreuse = "yellow tinged green" or "green tinged yellow"

teal = "blue tinged green" or perhaps "green tinged blue" for a so-called teal green

sunset, sunrise colors = "yellow tinged orange tinged red"

coral = "pink tinged orange"

olive = "green tinged yellow"

scarlet = "red tinged orange"

tan = "white tinged brown"

Some combinations of color might be:

yellow margined red (gold flower with a red picotee)

green centered white (as in a white-centered Hosta or a green flower with a white throat!)

brown banded silver (some bromeliads)

silver netted black (Heuchera)

white bar yellow (Lilium)

green tipped red (Sempervivum tectorum)

purple centered pink (common in Coleus)

red tinged violet (popular violet-red)

This syntax has been used for decades and is proven over many applications and genera. You can search for "brown" as the leading term for any brown. You can narrow down the search for "brown dark" or "brown light". You can further be much more specific and select for "brown light margined white" or "brown tinged red centered white mottled red". There are many levels on which boolean type searches can be run. You can even search for the field containing the word "margined" for any color with a contrasting margin of another color; or contains "bar" for all Lilium with a contrasting bar whether it be white bar yellow, white bar red, pink bar red, white tinged green bar red mottled green, or even yellow tinged orange bar red mottled black.

What is margined to one eye might be centered to another so try to list taxa in more than one record for accuracy. Give the user guidelines for when each pattern applies.

yellow centered green = green margined yellow?

If you prefer to be more specific these are good examples:

blue light

blue medium

blue dark
 blue light mottled white
 blue light centered blue dark (the center is a darker shade of blue than the main tissue)
 blue dark mottled white tinged violet (a dark blue with violet tints and spots of white)
 blue dark centered white mottled brown mottled red (a dark blue flower with a white throat, this throat mottled in both brown and red)
 blue medium bar white
 white tinged lavender mottled red (white blushed with lavender to lilac, also spotted red)
 white tinged pink light margined pink dark (this a white blushed a bit with a margin of a dark shade of pink than the major tints)

The use of parentheses can be used to clarify similar colors such as:

purple dark (burgundy)
 purple dark (blackish)
 purple dark tinged brown (muddy)

pink dark (magenta)
 pink dark (candy)
 pink dark (rose)

CULTIVAR	Species/Group	Size	Leaf Color	Hairs	Comments
Aaliyah	Arachnoideum	Small	red centered green	Web	Mostly with 5cm rosette, fairly loose web, older leaves rich burgundy red
Abba	Redbase	Large	Bluish-green tinged red	No	Frosty-green to greyish-green, incurved leaves with red bases and outer tints
Ace of Spades	Bigred	Large	red dark	No	Huge, slightly incurved rosette of very dark strap-like leaves
Achalm	Redbase	Large	red tipped green	No	Dark frosty bluish-green with rich rose-red bases
Adelheid	Redfrost	Medium	Red medium	Web	Tuftly-webby beauty from Smits (1991), greens up some but stays very frosty
Affine	Arachnoideum	Small	red centered green	Ciliate	Transition from a light cobweb to a ciliate form, rich rose-red outer leaves, frosty
Aglow	Orange	Medium	Orange tinged pink	No	Erect pink to orange leaves, truly glowing, center much greener, narrow blades
Agnes	Redfrost	Medium	red centered green	Web	Pretty rosy-red outers, center quite green, short web to large apical cilia
Akatumerenge	Redtip	Medium	Green tipped red	No	Japanese variety with big red tips to 40-50%, very sharp acute tips make it star-s
Albidum	Redtip	Large	Bluish-green tipped red	No	Flat, short leaves. It is not popular today but it's sport 'Oddity' is quite widely offer
Albiflorum	Grandiflorum	Small	green light	Velvet	A white-flowered form. Outers can be red but not always, mostly a greenie
Album	Arachnoideum	Small	Green Medium	Web	Almost all green in leaf. Flower petals are white and not pink to red as typical
Aldo Moro	Gold	Medium	Yellowish-green tipped red	No	Mix of golden-green tints, some amber, light olive, outers an appealing amber-ros
Alladin	Redtip	Large	Green tipped red	Ciliate	Long, very narrow blades with violet-red flushed tips, bright green, ciliate center
Akhenatum	Pink	Large	Pink tinged red	No	Big obovate, angular leaves in dusky pink with crossbands of silver and lilac. Qui
Ali Baba	Arachnoideum	Small	Green light	Web	Very symmetrical, uniform pale green Arach with a dense central web, outers with
Alice	Pink	Large	Pink tipped red	No	Pale violet-red tones on pink, effectively a glowing pink, big strap-like leaves, tips
Allison	Redfrost	Small	red centered green	Ciliate	Narrow, spidery leaves, lots of pretty cilia but no web
Altair	Gold	Small	Yellowish-green tinged pink	Velvet	Greenish-gold centers with outers a true bubble gum pink, blends with amber ton
Amanda	Tectorum	Large	Bluish-green tipped red	No	Wonderful for dusky base colors augmented with big triangular tips in rich violet-r
Amelunga	Bigred	Medium	red tipped green	Velvet	Mostly rose-red ion spring, tips greener with time, small velvety sheen.
Anke (Anchor)	Bigred	Medium	Red medium	Velvet	Dark red velvet in spring, very numerous short, wide leaves, quite refined modern
Anna	Pink	Medium	Green tinged pink	No	Mix of light pink, amber-rose, and frosty-green shades, older leaves show red tips
Apache	Bigred	Medium	Red center green	Ciliate	Narrow leaves form a waterlily shape, tips at first with bright silver cilia, very pointy

Semperfile. Here's one developing application of this syntax applied to Sempervivum and Jovibarba. You can select cultivars by size of rosette, leaf color, and whether there is velvet, webby (arachnoid), or ciliate vestiture (hairs). The cultivar groupings such as Redtip make it easier to find "green tipped red" cultivars as they are very common. The Bigred group have various red shades and tints but are mostly medium to large rosette in rich red tones. Major species groupings like Arachnoideum, Calcareum, and Tectorum are used as well.

TAXON/CULTIVAR	GROUP	HT	FLOWER COLOR	DESCRIPTION
4-You	Asiatic	48	Orange mottled red	very fine dark speckling in the brushmark
ABERLOUR	Oriental	48	Pink dark (magenta)	Rich candy pink, subtle basal spots, paler
ABRACCIO	Oriental	30	Pink light	wide tepals, few or very faint spots
Acoustic	Oriental	22	Pink bar white	white margined pink to pink with a white ba
ADORATION	Longasia (LA)	32	White	Clean, spotless white, very nice tapered te
AFRICAN QUEEN	Trumpet/Aurelian	46	Yellow tinged orange	Classic amber trumpets, a favorite for dec
After Eight	Oriental	20	White bar red	Big rose-red to dark pink bar (very variabl
Aktiva	Oriental	48	Pink bar red	Glowing peony pink, red bar, red spots, pr
ALBANY	Orienpet (OT)	24	White bar red	50:50 bicolor of red on white but less spot
ALBUFEIRA	Longasia (LA)	32	Pink light	Clean pink, paler to whitish center (not rea
Alchemy	Orienpet (OT)	60	Yellow bar red	The red is up to 85% surface, hanging flov
Alexis	Asiatic	36	Orange light	Wadekamper cross.
Allegretto	Orienpet (OT)	70	White bar yellow	Unspotted Oriental with a massive 50% yel
ALLROUND	Asiatic	30	yellow tinged orange	Amber-orange to a orangish-gold, upfacin
Altari	Oriental	44	White bar red	Lovely as the bar is at about 50% it's a cle
AMARONE	Asiatic	30	Red medium	1999 intro with slight reflex, slightly narrow
America	Asiatic	36	Red dark (burgundy)	Rich red, slightly paler edges.
AMETHYST ANGELS	Trumpet/Aurelian	70	Pink bar white	daylily look with gold throat, high reflex, me
Angel Choir	Asiatic	36	White	Nice reflex, a few central spots but effectiv
Annamaries Dream	Asiatic Double	36	White	Pure, unspotted white, obtuse tepals, not a
ANTEQUERA	Asiatic	30	Yellow dark (golden)	uniformly gold, not spots, paler yellow bud
Antique Lace	Asiatic	48	White mottled red	Slight reflexed white with variously sized da
Aphrodite	Asiatic Double	48	Pink tinged orange (salmon)	Light pink with salmon tints

The **cv-Lilium** spreadsheet/database uses traditional cultivar groupings like Oriental, Asiatic, Trumpet and some new ones like Orienpet (OT). The colors are selected and sortable top and make use of the bar pattern for that type of central marking come on lily tepals.

RGB Structural Imaging Analysis. This color analysis technology is so advanced and complex I have yet to figure it out. But give this website and their products a long look if you require very scientific analysis of plant colors and forms. It seems more geared to physiology and pathology research but no doubt some taxonomic applications could arise:

<https://qubitphenomics.com/rgb-structural-imaging/>

Some additional background reading I recommend are the following:

Paclt, J., 1983. A chronology of color charts and color terminology for naturalists. *Taxon*, pp.393-405.

Van Eck, J.W. and De Vries, D.P., 1995. Impartial assessment of rose (*Rosa*, 'Sweet Promise') flower colour with the aid of a chromameter. *Plant varieties and seeds: an international journal* edited by National Institute of Agricultural Botany, 7, pp.29-35.

Schmitzer, V., Osterc, G., Veberic, R. and Stampar, F., 2009. Correlation between chromaticity values and major anthocyanins in seven *Acer palmatum* Thunb. cultivars. *Scientia horticulturae*, 119(4), pp.442-446.

Wang, S. Modelling flower colour: several experiments.

<https://pdfs.semanticscholar.org/8371/887a9aac67555c0564c2394beeebd5145c3f.pdf>

We all know clonal mutations that are vegetatively white-tipped or yellow-tipped, starting with no visible chlorophyll.

White virescent = having white or cream-colored new growth which becomes slowly green or greener.

Yellow virescent = having yellow or gold-colored new growth which becomes slowly green or greener.

Purpurescence = have green new growth which matures to purple or violet shades (some *Prunus virginiana* cultivars)

Rubescence = having green new growth which matures to red shades

Aurescence = having green new growth maturing to golden or yellow shades

Purpureo-aurecent = having red or purple new growth maturing to golden or yellow shades (*Cercis canadensis* 'Flamethrower')

CHAPTER FIVE

FLORIMETRICS

We are going to exclude color studies here as that has been done in the previous chapter,

This useful form of biometrics is very useful in distinguishing cultivars and in fact is part of the requirements of both the United State and Canadian patent systems. Terminology is easily converted into numbers such panicle=1, cyme=2, spike=3, etc. The basic flormetric descriptors from the patents and cultivar literature in general are.

1. Inflorescences
 1. Type (panicle, cyme, etc.)(IT)
 2. Shape (domed, globose, subglobose, conical)(IS)
 3. Number per plant (IPP)
 4. Length (IL)
 5. Width (IW)
 6. Flowers per Inflor. (FI)
 7. Branching unit count (IBUC)
 8. Flowers per branching unit (FBU)
 9. Stem color (ISC)
 10. Rays per capitula (if Asteraceae) (RayPC)
2. Flowers
 1. Flower diameter (FD)

2. Corolla color aka "flower color" at maturity (FC)
3. Bud color (BC)
4. Corolla color pattern (picotee, basal blotch, central stripe, eyezone)(CCP)
5. Ray color (if Asteraceae)(RayC)
6. Ray position (horizontal, erect, drooping)(RayP)
7. Ray length (RayL)
8. Ray width (RayW)
9. Calyx color (CAC)
10. Calyx maximum height (CAH)
11. Calyx maximum width (CAW)
12. Pedicel Color (PC)
13. Width or diameter (FD)
14. Doubleness (petal count)(FDBL)
15. Doubleness type (anemone, hose-in-hose, full double)(DBLT)
16. Corolla Shape (tubular, funnelform, salverform, etc) (FCS)
17. Lobe or ray shape (elliptic, linear, filiform, ovate, etc.)(LOS)
18. Petal or ray apex (bifid, laserate, acute, acuminate, cuspidate, obtuse)(FPA)
19. Petal or ray incision depth (FPID) - important with any deeply cut or fimbriated genera

One interesting but not widely read paper is Josph Dvorak's 1978 paper called [A Four Year Lilac Study](#). It is a good introduction to the application of florimetrics to a complex genus where flower differences are pretty much all important.

I want to applaud the **Canadian Plant Patent** system for organizing the data into charts which unlike the US system with it's massive, inaccessible paragraphs makes the data very clear. Here's a very useful example of Echinacea purpurea 'Green Jewel' and some florimetric values to sort it out with a superficially resemblant, green-rayed cultivar. Good stuff and a great model to copy. This is detailed, cultivar-level taxonomy at it's very best.

Flower diameter (cm)

	'Green Jewel'	'Green Envy'
mean	8.34	11.06
std. deviation	1.35	1.27

Number of ray florets

	'Green Jewel'	'Green Envy'
mean	22.00	17.20
std. deviation	1.41	2.68

Ray floret length (cm)

	'Green Jewel'	'Green Envy'
mean	3.42	5.12
std. deviation	0.29	0.46

Ray floret width (cm)

	'Green Jewel'	'Green Envy'
mean	0.76	1.02
std. deviation	0.18	0.12

Colour of ray floret (RHS)

	'Green Jewel'	'Green Envy'
upper side	114D to 145B/C fading to 160D with maturity	145B/C and 67B/C

Disc: diameter (cm)

	'Green Jewel'	'Green Envy'
mean	2.65	3.73
std. deviation	0.37	0.55

Colour of disc floret (RHS)

	'Green Jewel'	'Green Envy'
mean	144A and 145C	197A and N172B

(This is then followed by a color image)

Let's look at **inflorescence length in Buddleia cultivars** and I take 100% of my data from Canadian patent records. There is a stunning difference if they are sorted by length in cm.

SODA POP PURPLE = 29.9

Adokeep = 27.6

Summer Skies = 20.8

SODA POP WHITE = 20.1

Black Night = 18.8

Purple Haze = 17.0

Peakeep = 16.9

Pyrkeep = 15.5

Ice Chip = 15.3

Nanho Blue = 14.8

Miss Ruby = 11.6

Santana = 8.4

Blue Chip = 7.6

One could further expand on the biometrics by adding leaf length, leaf color (light, medium, dark green, silvery, gray, gold), leaf width, inflorescence width, and corolla color by RHS value.

One group of experts that relies on florimetrics, ranging from actual, careful measurements to general observations, are **plant trial curators**. They evaluate primarily herbaceous perennials and annuals and rate them on a scale over the season. I've worked as a horticultural student a time or two on such projects and as a researcher follow many of the trials both famous and less well known. Typicall the plant trials or cultivar evaluation teams

stress these measurable traits when it comes only to flowers:

1. Earliest date of bloom
2. Last date of bloom (1. minus 2. = flowering duration)
3. Flowers per plant (scored over the season by date, some with a plotted graph), "floiferousness" overall
4. Flower stem strength (holds weight of flowers well? Non-flopping? No need to stake in full bloom?)
5. Flower fading tendencies (measured as color or surface, actual color values. I know azaleas which go from 100% white or pink to 100% brown - not good)
6. Clean petal or spent flower drop (do fading petals fall or cling? Is it a "self-cleaning" cultivar? Needs regular deadheading?)
7. Flower coverage over the canopy (ie. 2-80% surface)
8. Freedom from weather (wind, rain) damage, ie. no petal tearing or spotting
9. Uniformity of flowering (variously measured, usually meaning distribution over the canopy)
10. "Quality of the flower" (a term used by the RHS, subjective yet helpful. When you have experts in a genus scoring such things the measurement have increased value as they've seen scores if not hundreds of taxa over their lives)
11. Flower or inflorescence dimensions
12. Petal or tepal count (valued in more double genera trials such as Rosa and Camellia)
13. Flower color (typically corolla, calyx, or both)
14. Flower color uniformity in population (important for seed-raised material, did color vary much?, were there poorly colored seedlings?)
15. Flower size and shape uniformity in population (important for seed-raised material)
16. Reblooming ability after cutting back or dead-heading (measured as number of flowers produced after such defined events in pruning)
17. Vase life as cut flower (usually measured in maximum days)

One of the organizations who needs good florimetrics is the **American Hosta Society**, even though measurement of foliage is also of high importance is dual-talented genus. Take a look at there registrations and the measurements required here in this example:

<https://www.hostaregistrar.org/detail.php?id=529>

They focus on these metrics:

1. Scape height
2. Scape color
3. Scape bracts type
4. Flower color
5. Flower length
6. Flower shape
7. Bloom start date
8. Bloom peak date
9. Bloom finish date

It's perhaps appropriate was look at the **cultivar registration requirements** in terms of flormetric data by some other plant societies. By reason of anatomy and floral portions considered colorful, textural, and ornamental the requirements will vary. These include forms linked here:

1. Dianthus - <https://www.rhs.org.uk/plants/pdfs/plant-registration-forms/dianthus-name-registration.PDF>
 2. Hemerocallis - <https://daylilies.org/DaylilyDB/regform.php>
 3. Iris - <http://www.irises.org/wp-content/uploads/2019/10/Reg-Form-R4-Single.pdf>
 4. Lilium - <https://www.rhs.org.uk/plants/pdfs/plant-registration-forms/lily-name-registration.PDF>
 5. Narcissus - <https://www.rhs.org.uk/plants/pdfs/plant-registration-forms/daffodil-name-registration.pdf>
 6. Paeonia - <https://americanpeonysociety.org/wp-content/uploads/2019/04/Registration-Form-PDF-Jakubowski.pdf>
 7. Rosa - rose.org (requires registration to view their pages)
 8. Saintpaulia - http://www.avsa.org/sites/default/files/files/Plant_Registration/Application%20for%20Registration%20%20e-2019.pdf
-

CHAPTER SIX

FORMATION OF CULTIVAR CLONES, IMPOSTER CLONES, SEEDAGE DECLINE, AND CLONIFICATION

(under review)

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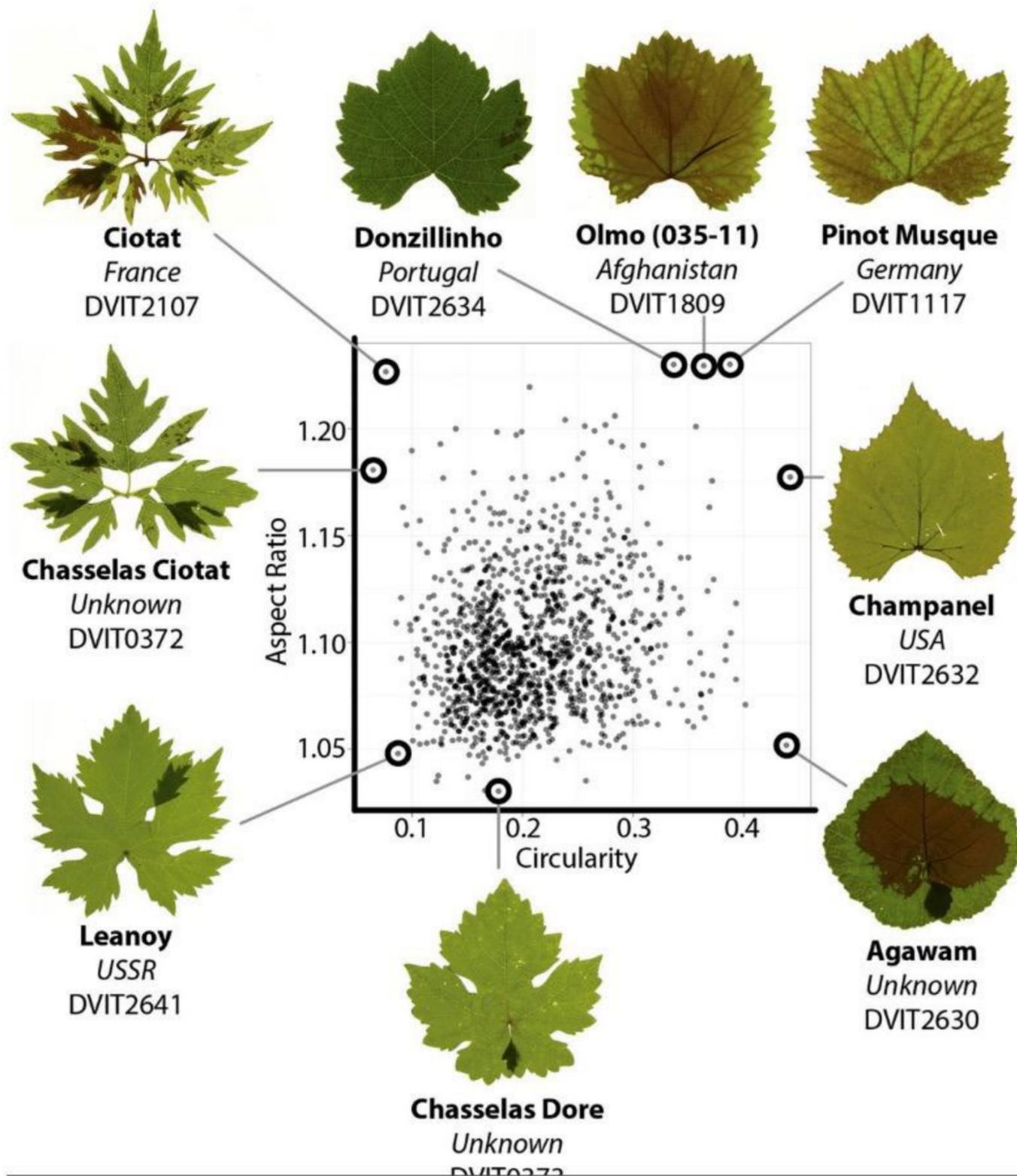
Please link only to www.cultivar.org for reference to this page

CHAPTER SEVEN

PHYLLOMETRICS

Among biometric studies, the field of phyllometrics is one of the most developed. It is the measurement of leaves, which among ornamental plants are highly variable for lobing, dissection, length, width, shape, color, and so on.

Some of the important work has been done in *Vitis* among the world's billions of dollars worth of grapevine which are more about foliage than fruit most of the year. An assortment of papers are listed: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C47&q=phyllometrics+vitis&btnG=



Ampelography or the study of Vitis/grape leaf shape started probably as soon as some farmer could tell one variety of grape from another in the wild and later his vineyards. Academically it was Galet in 1952 and more recently in 2014 Chitwood et. al. did analysis on 1200 different accessions and one of their plates is shown above comparing **Circularity** and **Aspect Ratio**. The full paper is recommended and found here:

<http://www.plantphysiol.org/content/164/1/259/tab-figures-data>

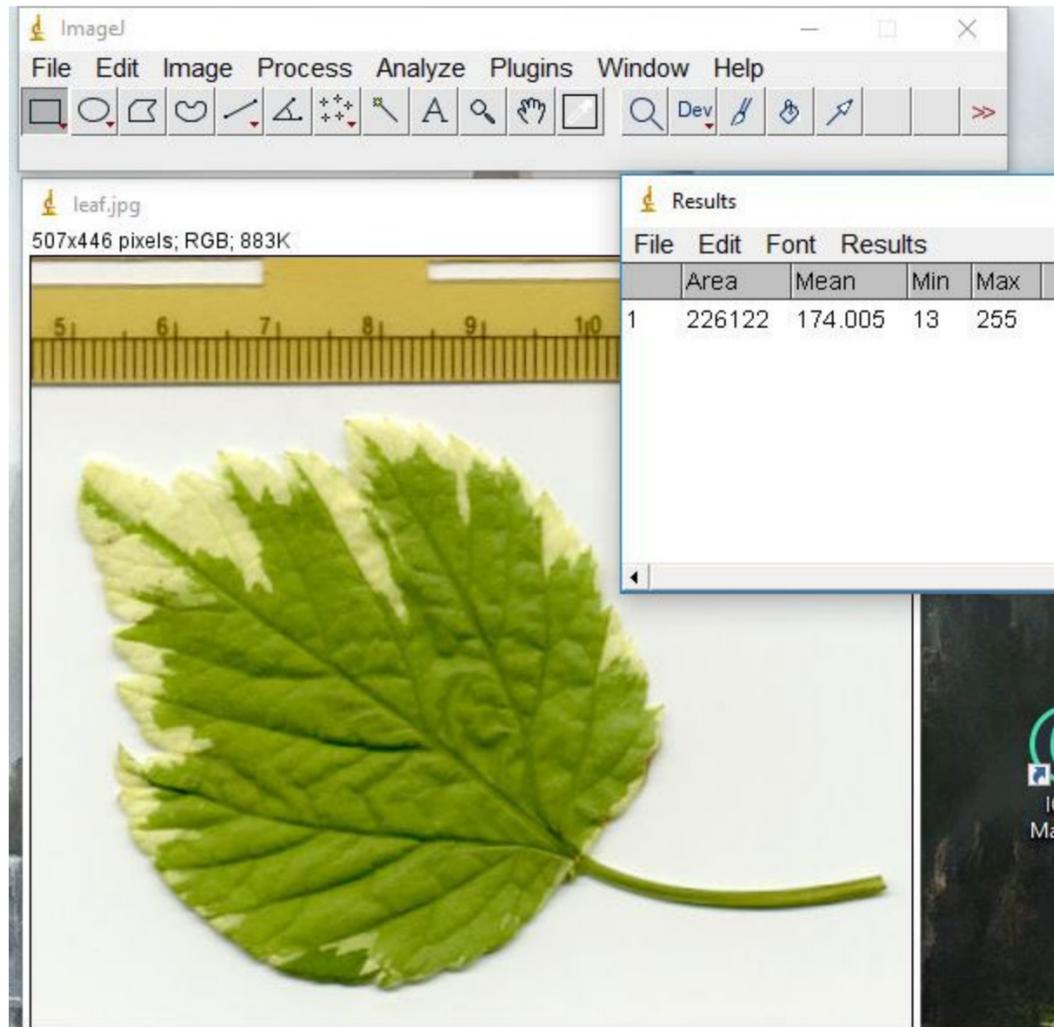
Elliptical Fourier Descriptors (EFDs) are an important part of modern ampelography and why not apply this to other palmate-leaved, lobed and incised genera starting with Acer? Clearly the leaves in the plate above shows very very incised grape leaves equally on the same order and extremity as found in ornamental taxa. A good ornamental application of EFD is *Primula sieboldii* cultivars:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4242211/> as well as this one on *Passiflora* species:

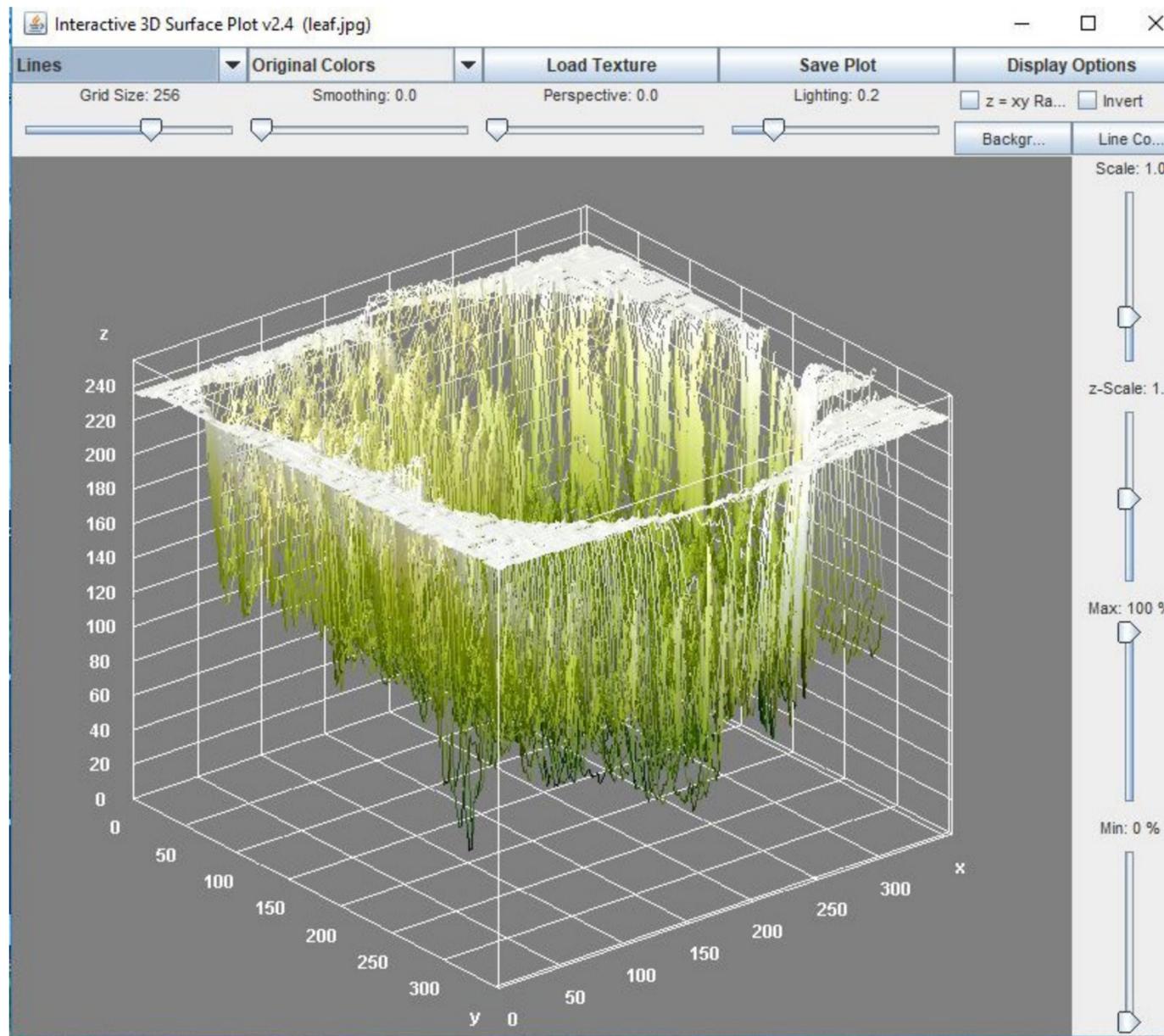
<https://academic.oup.com/gigascience/article/6/1/giw008/2865207>

Cassandra Kitchen of Saint Louis University did a wonderful presentation on grape phyllometrics and it's very approachable yet detailed and a fine summary:

<http://www.missouribotanicalgarden.org/Portals/0/Science%20and%20Conservation/PDFs/REU/2014/Cassandra-Kitchen-Vitis-presentation-min.pdf>



The ImageJ software with their example of a leaf from File-Open Samples. It just happens to be variegated so suited my tests just fine! I literally pushed one menu option and got this plot below that analyzes color distribution. Wow! The white to cream margins float to the top as it were. The different shades of cream, lime, and green have their levels too.



If you're interested in the **ImageJ software** to compute aspect ratio and circularity of leaves it is free from the National Institutes of Health in the US. Glad to see tax dollars doing some useful good for once. This is a very well developed, menu-driven program with excellent examples and documentation - not one of those "here's my script and you figure it all out".

<https://imagej.nih.gov/ij/download.html>

The Dickinson Lab has a good introductory page on morphometrics including traditional, landmark-based, and outline-based techniques:

<http://labs.eeb.utoronto.ca/dickinson/MorphometricMethods.HTML>

The use of EF or EFD for plant identification has been written about more than I realized. This is one very interesting paper that achieved overall accuracies with known taxa of about 89% and as high as 93% with some genera and situations. The technique not only used Elliptic Fourier values but **chain encoding** and **Canonical discriminant analysis**.

Neto, J.C., Meyer, G.E., Jones, D.D. and Samal, A.K., 2006. Plant species identification using Elliptic Fourier leaf shape analysis. Computers and electronics in agriculture, 50(2), pp.121-134.

https://www.researchgate.net/profile/Joao_Camargo_Neto/publication/223197164_Plant_species_identification_using_Elliptic_Fourier_leaf_shape_analysis/links/5c541c9d299bf12be3f2739c/Plant-species-identification-using-Elliptic-Fourier-leaf-shape-analysis.pdf

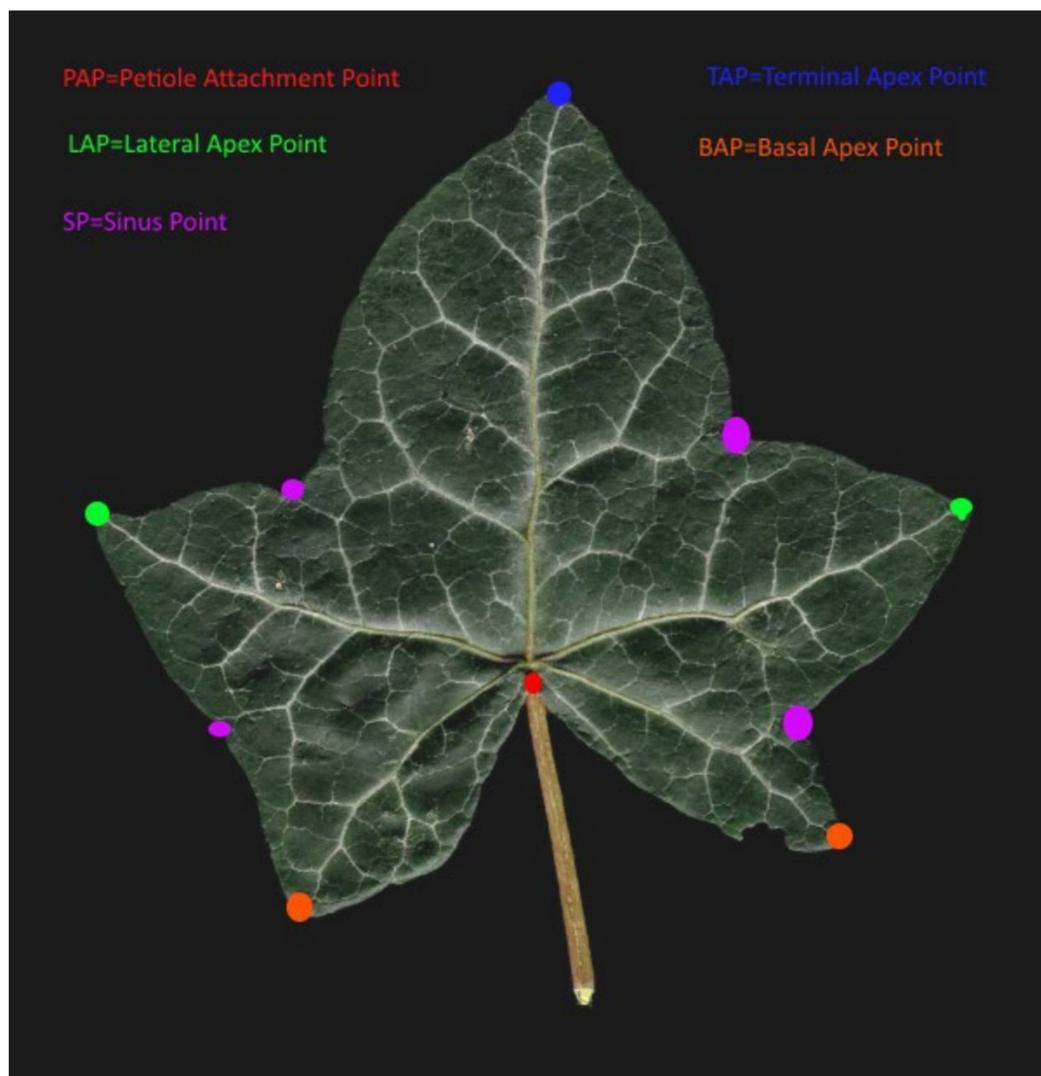
Another paper perhaps ore of value to ornamentals taxonmists is this analysis of the very variable Passiflora taxa. This could be applied to the many cultivars and hybrids of this genus and perhaps many other palmately-divided genera and their cultivars.

Plotze, R.D.O., Falvo, M., Pádua, J.G., Bernacci, L.C., Vieira, M.L.C., Oliveira, G.C.X. and Bruno, O.M., 2005. Leaf shape analysis using the multiscale Minkowski fractal dimension, a new morphometric method: a study with Passiflora (Passifloraceae). Canadian Journal of Botany, 83(3), pp.287-301.

https://www.researchgate.net/profile/Rodrigo_Plotze/publication/233652242_Leaf_shape_analysis_using_the_multiscale_Minkowski_fractal_dimension_a_new_morphometric_method_A_study_with_Passiflora_Passifloraceae/links/02e7e524dd6add7a1c000000.pdf

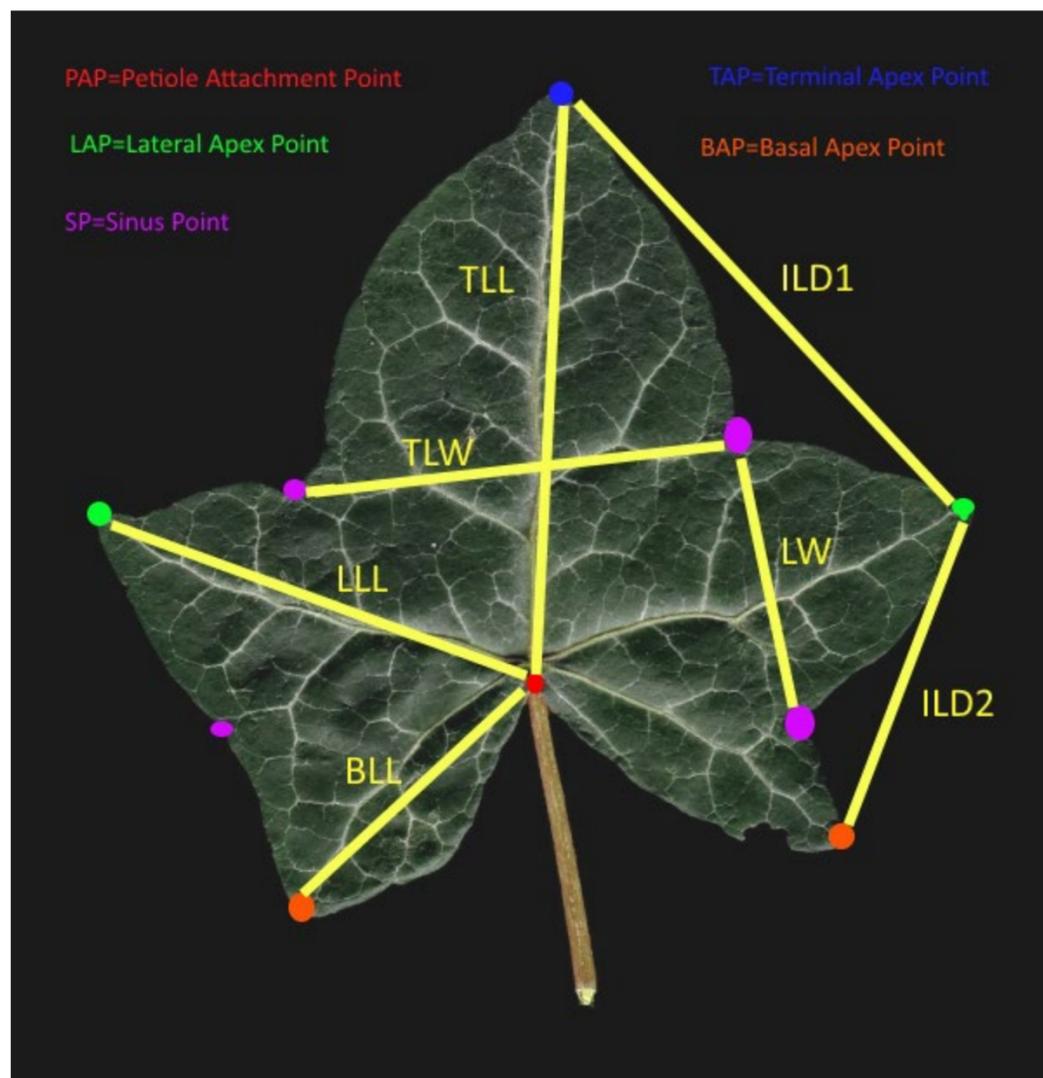
One of the central principles of phyllometrics is what is called **morphological landmarks**. By measuring the length between landmarks and sometimes angles involving them you can easily describe complex foliage patterns. The major landmarks, using the terminology I prefer from my studies of Hedex helix cultivars are:

- **Petiole Attachment Point (PAP)**, a defined point where the end of the petiole intersects with the base of the lamina or blade
- **Terminal Apex Point (TAP)**, a defined point at end or distal portion of the terminal lobe, the very tip of the leaf apex
- **Lateral Apex (LAP)**, a defined point at tne end or distal portion of the lateral lobe just adjoining the terminal lobe. In 7-9 lobed leaves there will be additional laterals that can be designated LAP1, LAP2, and LAP3.
- **Basal Apex Point (BAP)**, a defined point at the end of the lowest lobe at it's most distal point from the midrib.
- **Sinus Point (SP)**, a defined point at the lowest or deepest point of a leaf sinus (lobe gap) or at least the one closest to the midrib. These can be called First Sinus Point, Second Sinus Point, etc. moving down the blade from top to bottom. Many researchers will use a middle lobe if there are many choices such as in Quercus. In Hedera, the sinus between the terminal and lateral or side lobe is most important in most cases.

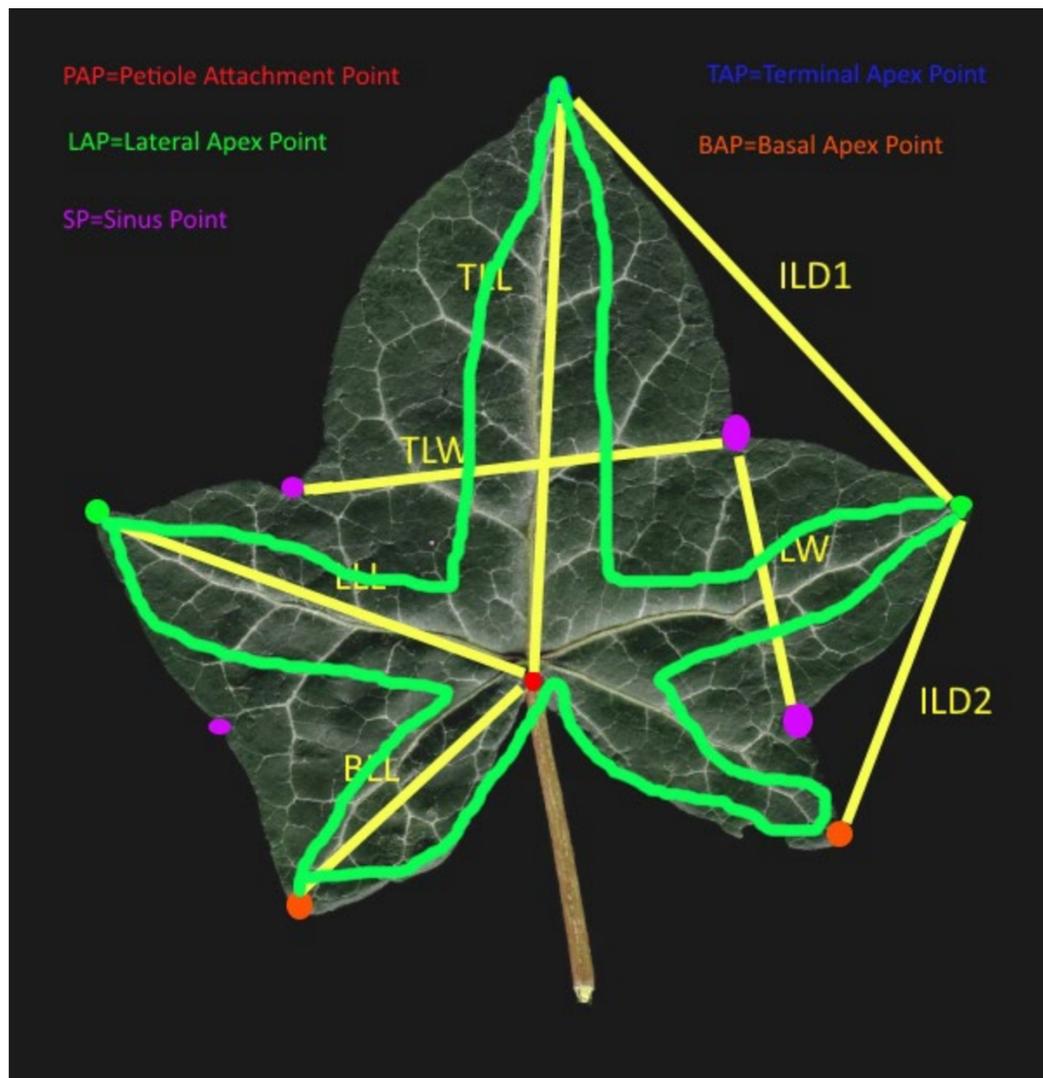


The plate above shows the major landmarks on a palmately lobed leaf such as *Hedera helix*. Once these landmarks are plotted, one can deduce other measurements in a geometric fashion that does not require lobes or veins to be either straight or uniform. You just measure point to point. For example these lines can be named:

- PAP - TAP = Terminal Lobe Length (TLL)
- highest SP to highest SP = Terminal Lobe Width (TLW)
- PAP - LAP = Lateral Lobe Length (LLL)
- PAP - BAP = Basal Lobe Length (BLL)
- TAP - SP = TAP-SP Line (TAPSP)
- TAP - LAP = Inter-Lobe Distance 1 (ILD1)
- LAP - BAP = Inter-Lobe Distance 2 (ILD2)
- SP - SP below it = Lobe Width (LW)



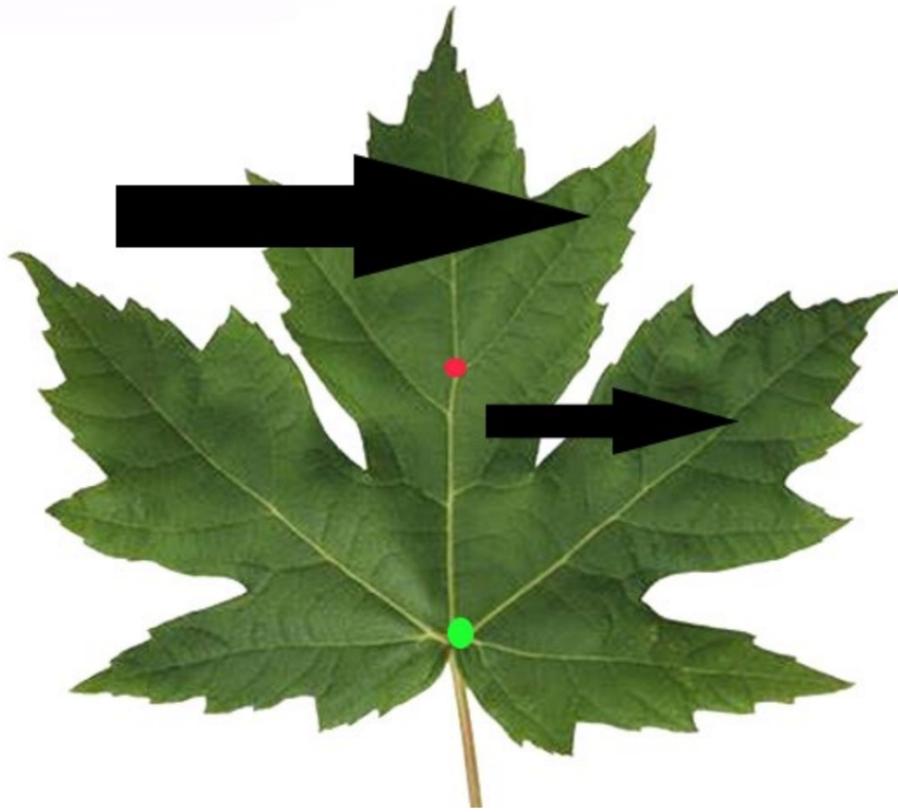
Take a moment to study and get your eyes oriented to these lines and their relative relationships. If you have a similar maple, ivy, or other palmate blade handy mark out these same measurements on your sample and compare to this leaf.



In the image above I have superimposed a Birdfoot Group ivy similar to 'Asterisk' over this species type leaf. Some of the normal leaf tissue is missing and that's about the main difference. Note that some measurements like IL1, IL2, TLL, LLL, and PLL remain the same. Those are not good values to separate out all the cultivars on their own! But if one looks at the TLW, the Birdfoot lobe is about 1/3 as wide and so is the lateral LW. TLW is therefore a very important metric in the study of Hedera and other palmates with deeply lobed, incised, or larger-lobe cultivars.

In some cases like Birdfoot ivies one can almost define this cultivar group by phyllometrics alone. If the ratio of TLW to TLL is about 1:10 to 1:4, we have a very narrow terminal lobe in that birds-foot type pattern. Remember that a low TLW can mean the entire leaf is miniaturized or very small with a similarly tiny TLL. If you defined the Birdfoot Group by saying they have a TLW of 1.5cm or less (which all pretty much do), you'd be including miniature ivies with a TLW and TLL both about 1cm and they would be wrongly classified. If you use a ratio for these miniatures, the TLW:TLL is closer to 1:1 and a much accurate separation than based on one metric alone.

I always get the question about Hedera phyllometrics when it comes to unlobed cultivars with perhaps an ovate or suborbicular leaf. We score the TLW the same as Lamina Width and that works well in any analysis. IL1 is zero (0) and this way one can find the unlobed cultivars easily in a data matrix.



In phyllometrics the **correct identification of landmarks** is vital. Look at this *Acer saccharinum* leaf above. The black arrows point to two different major lobes. Which should be considered the true lateral lobe? And why? The lower right arrow is the true lateral lobe. Look at its major vein and where it attaches. The green dot shows this is the first side vein connecting at the Petiole Attachment Point (PAP) at the base of the midrib. That other large lobe at the top has a major vein that connected to the midrib (red dot) and so it is not the true lateral lobe but instead a **sublobe** or **secondary lobe** off the terminal lobe. Sublobes by definition branch off of the major veins including the midrib, lateral vein, basal vein, and any other interbetween in the case of 7-9 lobed palmate leaves. **True lobes**, secondary, tertiary, basal, etc. have a midvein connected direction to the petiole or PAP landmark. Think of sublobes if you wish as mega-teeth for purposes of discussion but one can define what is a sublobe by length or size if you prefer. In the case of Acer leaf phyllometrics I like to use these measurements in addition to those show in in the Hedera examples like TLW and LD (Lobe Depth) discussed below.

- Total number of Teeth + Sublobes on Terminal Lobe (TL-TC) aka Terminal Lobe Tooth Count
- Total number of Teeth + sublobes on Lateral Lobe (LL-TC)
- Total number of Teeth + sublobes on Basal Lobe (BL-TC)
- Vein Length of Largest Sublobe on Terminal Lobe (TL-VLLS)
- Vein Length of Largest Sublobe on Lateral Lobe (LL-VLLS)

Be certain to measure Inter-Lobe Distance (ILD) from the apex of the terminal lobe to the apex of the true, lateral lobe, skipping over the terminal's sublobe. The gap between the true, lateral lobe and terminal's largest sublobe has been called a **false sinus** by some investigators. In other words, the sublobe is actually intruding into or splitting the true sinus gap and not part of its formation. That said, measuring both could prove useful if one defines all the measurements very carefully.

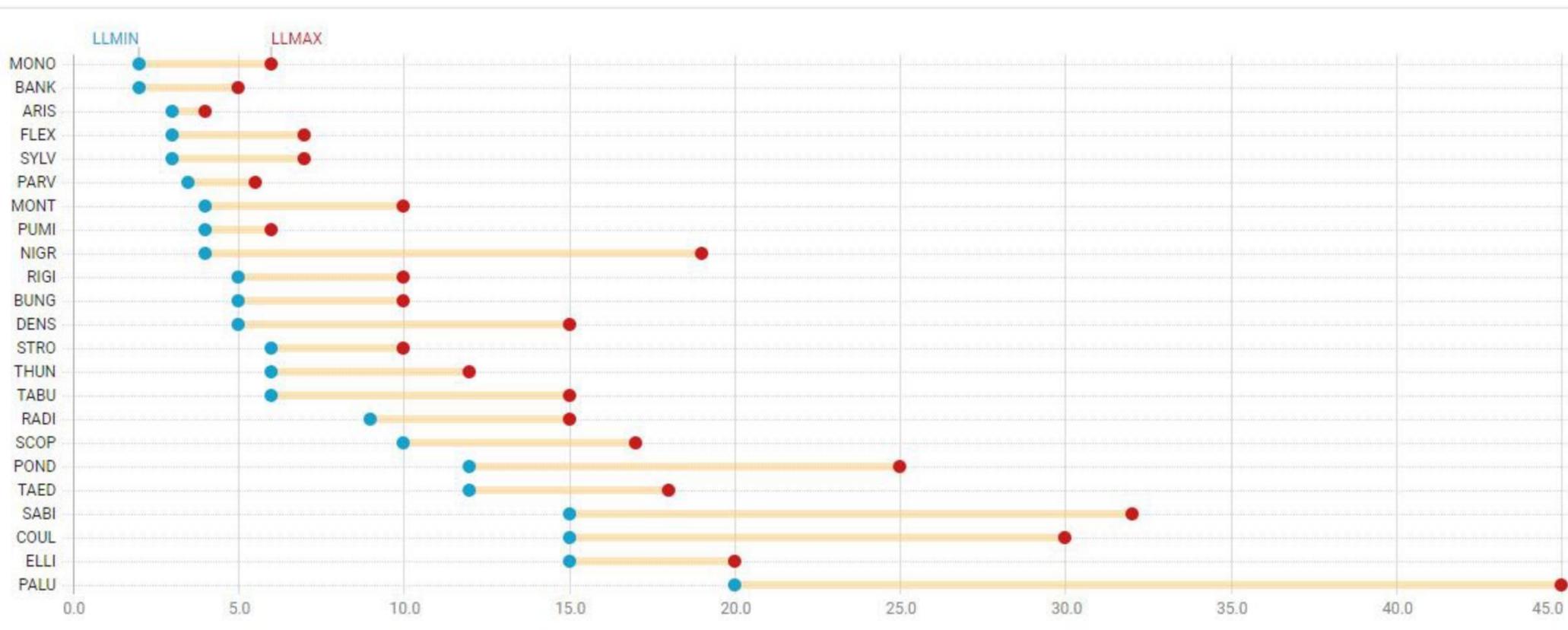
Also fundamental to effective phyllometrics is the use of **metric ratios**. Absolute, gross values or measurements will vary with climate and culture but ratios often stay fairly constant. The most simple one that I have seen used in elementary school as a math lesson is **Length to Width Ratio (LWR)**. A

narrow willow leaf might have ratios of 1:5 up to 1:10. A round leaf could be expected to be about 1:1 in some cases.

Different measurements of Leaf Width (LW) occur and some phyllometric studies sometimes utilize more than one. Here are the common ones and a few being used more and more:

- Maximum Leaf Width (LWmax) = the widest measurement possible on the leaf measured on a line roughly perpendicular to the midvein and touching each margin, left and right. This is the common or usual way to measure it
- Position of LWmax - how far up or down the midrib does the widest point occur, sometimes on a scale of 1 to 100, 50 or 50% being midway up. An ovate leaf might give a value of 20 or 20% up being before the center where an obovate leaf might score an 82 or 82% up, being toward the upper portion, numbering 1 at the base and 100 at the top. You can use an actual measurement along the midvein as in the following metric
- Height of LWmax = distance between the PAP and the LWmax or widest point in centimeters. This can actually be a negative number like -8 for a very wide cordate base that is wider than the rest of the blade and below the PAP.
- Leaf Width 1/8 way down from the apex (LW1/8apex) = the width measured on the highest line when the blade is cut into 8 units.
- Leaf Width 1/8 way up from base (LW1/8base) = width measured on the lowest line when the blade is cut into 8 units, this point starting at the PAP
- Leaf Width 1cm down from apex (LW1cmapex) = measured 1cm from the apical tip
- Leaf Width 1cm up from base (LW1cmbase) = measured 1cm up from the PAP. Note that I mentioned some blades are widest below the PAP and so neither 1cm up nor 1cm down will capture the widest point in those cases.
- Quarter cut values - I have seen one researcher fold the leaf in half and then in halves again. The width is measured on each of the three folds. This is easy for field work. Based on these three, reconstructed lines you can get a good idea of the leaf shape.

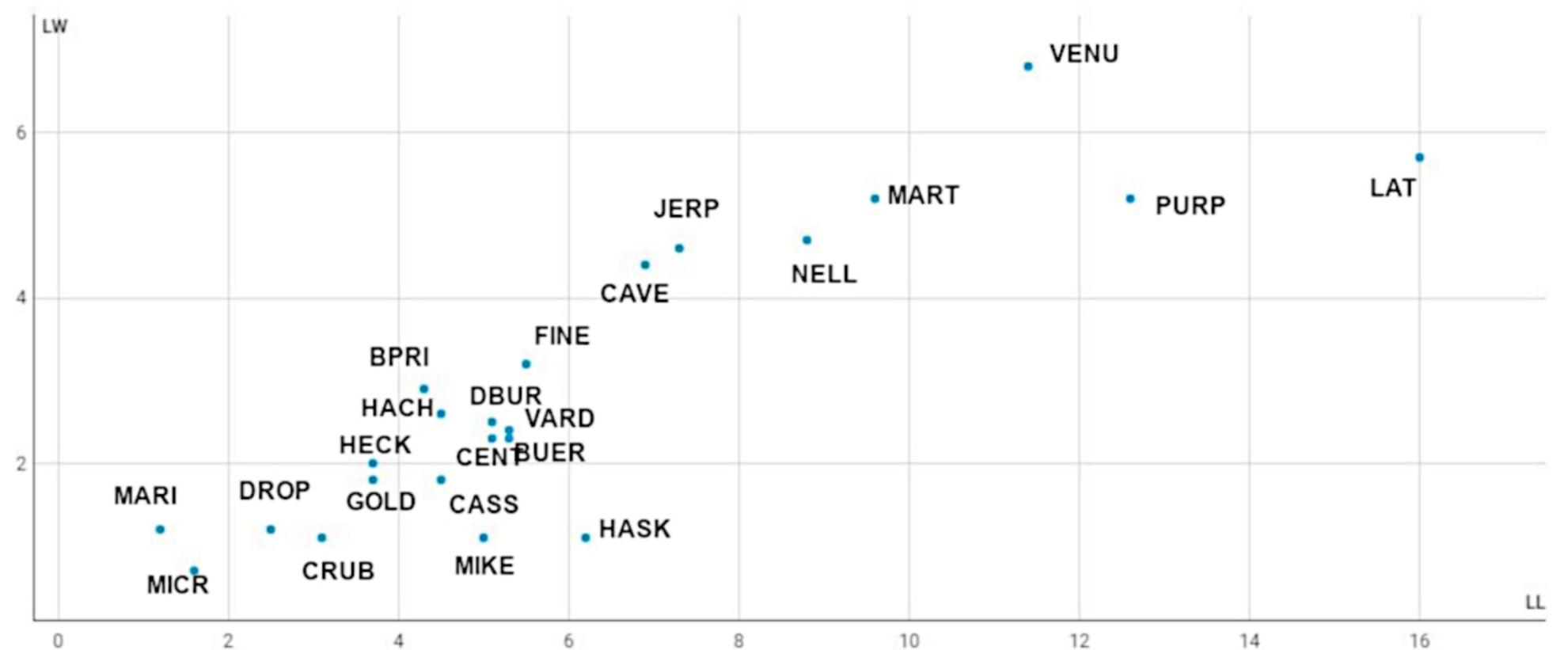
The **range of values** of Leaf Length (LL) and Leaf Width (LW) are often informative and while overlap among taxa is common, sometimes probabilities of an ID increase unless the plant is a hyper-vigorous or dwarf mutant. **LLmin** (Leaf Length Minimum) and **LLmax** (Leaf Length - Maximum) are the lowest, commonly observed (not outlying) lamina length measurements and highest, commonly observed value, respectively. I took a few minutes and got some range values for the genus *Pinus* from the Floras of China and North America, which also include some European species. I dropped this simple data into www.datawrapper.de, one of the easiest to use online graphing programs that requires no sign-up or log-in as long as you snip/screen capture your own image. This graph is just a simple of what can be done. For example you could superimpose the leaves per fascicle count over the length. Hopefully these abbreviations will make sense. If not, you don't know your conifers very well.



There are different **metric value classes** within each descriptor (metric, character trait). For Leaf Length (LL) lets consider the following which apply to nearly ever measure with a good, full dataset:

LL	single measurement	6.1
LLrange	range of values in dataset	4.1 - 6.8
LLmin	minimum value in dataset	4.1
LLmax	maximum value in dataset	6.8
LLmean	mean (average) value	5.4
LLmedium	median value	5.0
LLsd	standard deviation	+/- 0.23

Mean Leaf Width vs. Leaf Length in Evergreen Taxa of Garden Ilex

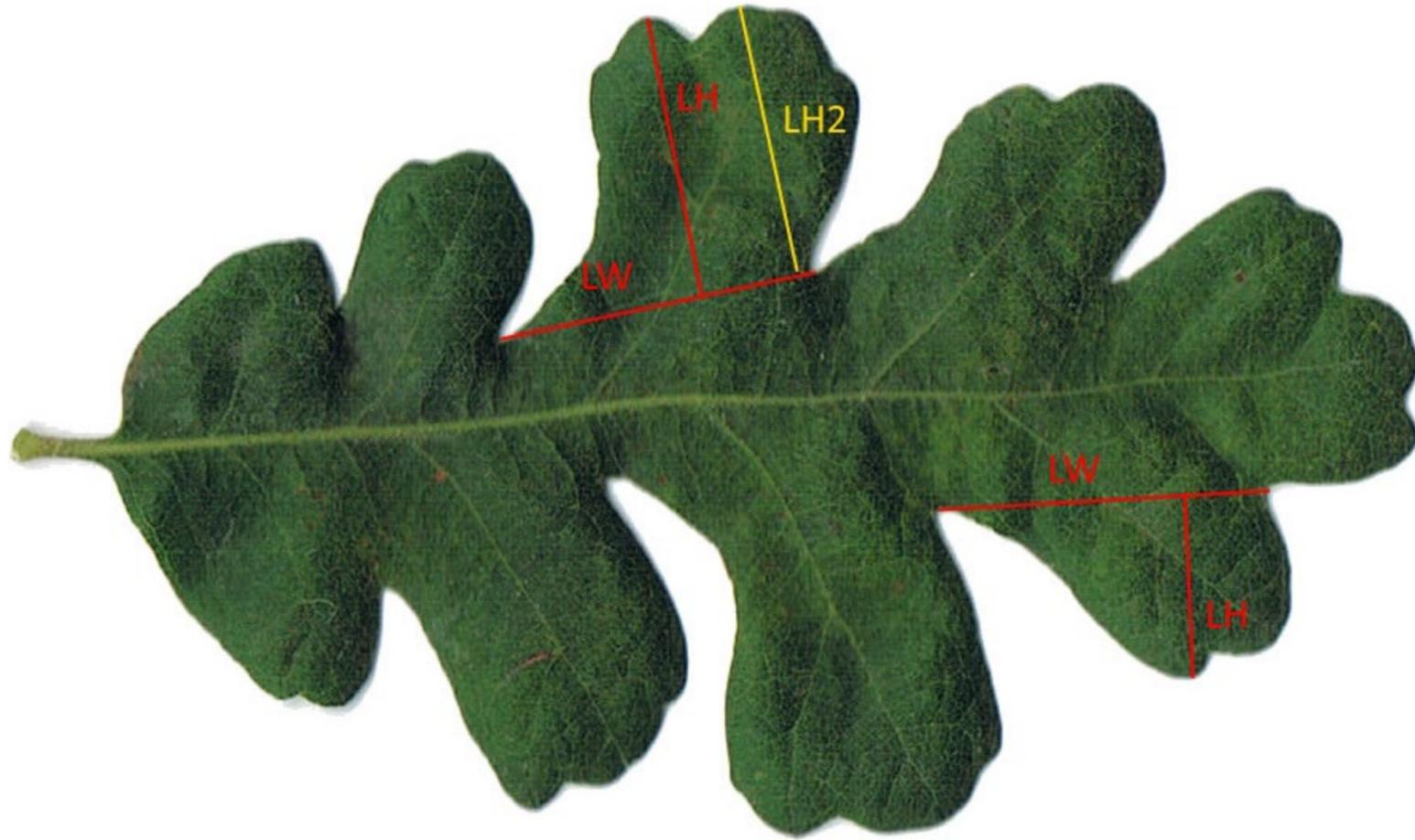


BPRI=*x meserveae* 'Blue Prince', BUER=*Ilex buergeri*, CASS=*Ilex cassine*, CAVE=*opaca* 'Cave Hill No. 1', CENT=CENTENNIAL GIRL, CRUB=*vomitoria* 'Carolina Ruby', DBUR=*cornuta* 'Dwarf Burford', DROP=*crenata* 'Drops of Gold', FINE=*cornuta* 'Fine Line', GOLD=*vomitoria* 'Gold Leaf', HACH='Hachfee', HASK=*opaca* 'Williams Haskins', HECK='Heckstar', JERP=*opaca* 'Jersey Princess', LAT=*Ilex latifolia*, MARI=*crenata* 'Mariesii', MART=*x koeniana* 'Martha Berry', MICR=*vomitoria* MICRON, NELL='Nellie R. Stevens', PURP=*latifolia* 'Purple Power', VARD='Patricia Vardeer', VENU='Venus'

This is my original research using the mean values of LW and LL among species (as garden typical) and cultivars available in my neighborhood and local plant collections. The overall four largest taxa (LAT, PURP, MART, VENU) are derivatives of *Ilex latifolia* with its very huge blades. CAVE and JERP are large-bladed *Ilex opaca* and they approach each other. The smallest two are MARI and DROP, tiny-leaved forms of *Ilex crenata*, the later derived from 'Convexa'. MICO or *Ilex vomitoria* MICRON® has the smallest leaf area of all. MIKE and HASK are extreme leaf mutations of their respective species, both quite narrow but also long, linear, lanceolate and narrowly elliptic for the most part. This plot was also done with [datavrapper.de](https://dataviz.wrapp.de/), accurate, fast, and no strings attached.

The **phyllometrics of leaf lobes** is a curious, fun, and useful one. It has contributed to understanding among taxonomist of *Quercus*, *Acer*, and *Ilex* hybrids and is eminently useful in understanding the garden cultivars too. In the case of the maples and oaks we have both **primary lobes** and **secondary lobes**, the later being branched from the main lobes. There needs to be separate metrics for each set and if one is covering incised *Acer palmatum*, you may need to go down to tertiary and quaternary levels of branching or lobing.

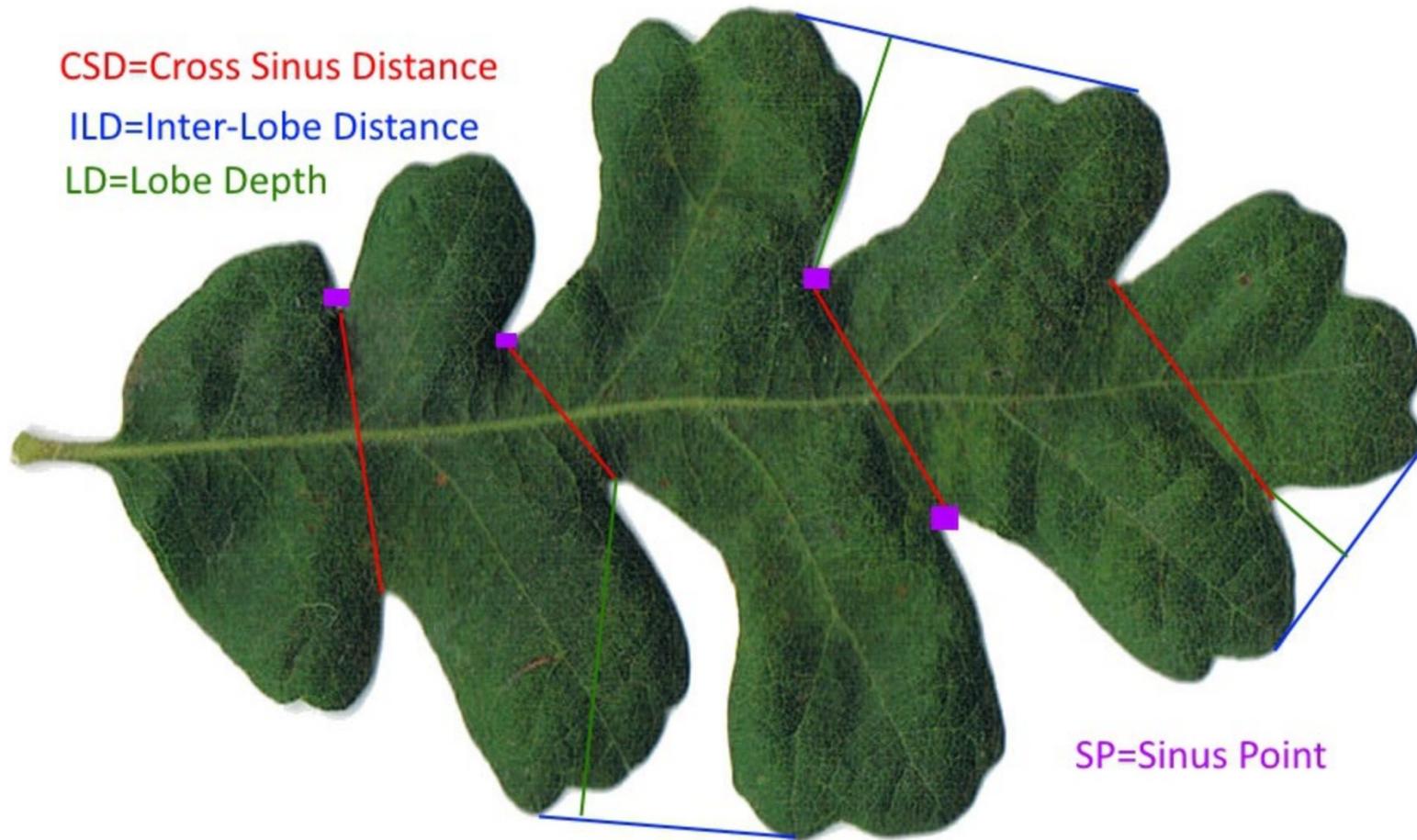
Fundamental to measuring lobes is the Sinus Point (SP) drawn from one sinus (lobe gap) to another. The **Lobe Width (LW)** is measured from point to point along this line. A line perpendicular to that line touching the apex of the lobe or the closest thing to that vague mark is the **Lobe Height (LH)**. Always define your measurement techniques in any study or publication. This also applies to spinose teeth such as *Ilex* but on a micro or smaller scale.



The use of perpendicular lines is shown above. In the case of the gold LH2 line it uses an alternate apex of the lobe but is nearly the same measured value. You may ask why we don't measure the lobe LH along the secondary vein or midrib of the lobe? In many leaves this vein is indistinct and in some genera fan-shaped, non-linear or branched.

These can be named Tooth Height (TH) and Tooth Width (TW). In the case of *Acer palmatum* cultivars, one can measure both the lobes and the teeth.

The plate below show the Sinus Point or SP defined in lavender. From the left SP of the same position of lobe across the midrib to the next SP is called the **Cross Sinus Distance (CSD)**. It is a good measure of how deeply incised or lobed a leaf has become. This value can be as low as 5-10mm in a highly lacerate or dissected leaf. The **Inter-Lobe Distance (ILD)** or **Inter-Tooth Distance (ITD)** can be difficult to determine if there is more than one distance peak or apex to the lobe. Using a perpendicular line between the ITD and SP you measure a standardized way the true **Lobe Depth (LD)**.



While on the top of marginal leaf teeth we might also discuss the merits of the metric **Teeth Per Side (TPS)**. This has been shown to be highly important in the separation of *Coleus* cultivars from our study of more than 300 cultivars with the International *Coleus* Society. Two resemblant cultivars may both have broadly ovate golden lamina but one may have 6 teeth per side while resemblant has more than 14. TPS is scores as zero if there is only one apical tooth or apex point, being classically an entire margin. TPS is also very important in separation of *Ilex* cultivars, especially those bred from the more spinose species.

Vein Pair Count (VPC) (measured on one side as pairs) is important in a number of genera including *Carpinus* and *Alnus*. The American Hosta Society uses it too and it's somewhat correlated to leaf size and plant vigor. Looking at their Register data: 'Blue Angel' has 12 pairs while 'Blue Arrow' has 10 pairs and the tiny 'Blue Mouse Ears' just 8-9. 'Church Mouse' can have as few as 6 pairs (up to 8) while the massive 'Sum and Substance' regularly has 12 pairs. The massive massive 'Empress Wu' usually has 17-18 vein pairs or as many as 11 more than some 'Church Mouse' leaves. Of course, leaf measurement ranges tell the difference better but among similarly sized cultivars, vein count can differ in meaningful ways. In his very functional, practical *Alnus* key, John de Langhe splits species in one division by 5-10 pairs and the other group 10-15 per side. In his key which wisely includes both *Ostrya* and *Carpinus* in a single key, note his use of vein pairs in the couplings as show below.

- shoots without male catkins). *Carpinus*
- 03 a Lamina margin in apical half, with 2-5 secondary teeth between the primary teeth. Secondary veins often straight. *O. carpinifolia*
- b Lamina margin in apical half, with 1-2 secondary teeth between the primary teeth. Secondary veins often curved in the middle. 04
- 04 a Secondary veins predominantly 11-15(-17)/side. Bud brownish at least in part, dull and pubescent (sometimes glabrescent at end of season). *O. virginiana*
- b Secondary veins predominantly 9-13(-15)/side. Bud greenish, shiny and +/- glabrous. *O. japonica*
- 05 a Lamina US deeply impressed, with 15-35 secondary veins/side. Midvein glabrous or almost so. 06
- b Lamina US smooth to +/- impressed, with 6-16 secondary veins/side. IF secondary veins 16-20/side, then midvein densely pubescent. 09
- 06 a Secondary veins 24-35/side. Lamina midvein length predominantly >15 cm. *C. fangiana (Distegocarpus)*
- b Secondary veins 15-25/side. Lamina midvein length predominantly ≤15 cm long. 07
- 07 a Lamina base cordate. Lamina margin in apical half with 2-3 secondary teeth between the primary teeth. Secondary veins 15-20/side. *C. cordata (Distegocarpus)*
- b Lamina rounded or to cordate at base. Lamina margin in apical half with 1-2 secondary teeth between the primary teeth. Secondary veins 18-25/side. 08

Relating to teeth and lobe measurement is **Undulations Per Side (UPS)**, **Undulation Height (UH)**, and **Undulation Spacing (US)** that is important in genera favored for wavy margins of the leaf. Counting the UPS is easy but should be expressed as a range. Even slight undulations can be measure from the crest of one wave to the next (US). The vertical distance when viewed from the side is the UH which can be in millimeters or occasionally in centimeters if extreme. Be careful not to use herbarium material is undulations can be created during drying that do not represent the taxon. Live material is important.

The roughness or texture of leaves is highly taxonomic at times and this is known generally as **Leaf Rugosity (LRug)** or how rugose the lamina appears to be. There studies on how to measure this and this is good place to begin:

<https://www.sciencedirect.com/science/article/pii/S1537511015000756>

Species can easily be separated in some groups, mainly hairy woody plants by leaf trichomes. Cultivar affinity to a species or hybrid of species is often possible by **trichome analysis**. Google Scholar shows 7000+ articles for "leaf trichomes" so it's a very broad field applied to many taxa and for many reasons, not all taxonomic. In 1976 Dr. James Hardin wrote the following paper and because he was a professor and thesis advisor of mine I was exposed to it in 1982 and got to view some of his amazing SEM images that determined true oak species from each other and those which were hybrids. Trichomes are independent of leaf shape so those taxa which lots of polymorphism as well as juvenile phasing can still be sorted out by their hairs. Turns out we had about thirteen Quercus hybrids just in the Raleigh, North Carolina area hiding among the gardens, streets, and parks there. Some had two species in the mix, others three, and perhaps one with four! As the great woody plant taxonomist he was, Hardin applied his trichome techniques to Betula, Carpinus, Fraxinus, Castanea, Alnus, Magnolia, Cornus, Carya, Fagus, Tilia, Rhus, and other genera.

Hardin, J.W., 1976. Terminology and classification of Quercus trichomes. Journal of the Elisha Mitchell Scientific Society, pp.151-161.

A few years later the work matured to these conclusion:

Hardin, J.W., 1979. Patterns of variation in foliar trichomes of eastern North American Quercus. American Journal of Botany, 66(5), pp.576-585.

Trichomes have had an interesting role in the **Hedera taxonomy** too including studies of cultivars and wild parents of cultivars which sometimes

amount to unique, local populations that have been cloned. The various papers can be viewed here:

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C34&q=hedera+trichomes&btnG=

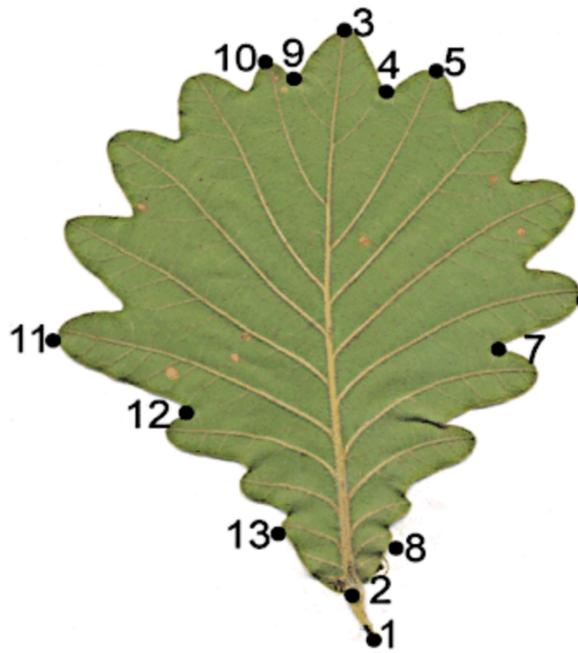
Phyllometrics of succulents such as members of Crassulaceae are important in ornamental taxonomy. Sempervivum change a good deal spring to summer and in cold winter so are quite challenging. In general I recommend these metrics:

1. Mature rosette diameter (if any)
2. Internodal distance (non-rosette forms mostly)
3. Plant height
4. Plant width
5. Leaf shape (obovate, lanceolate, spatulate, broadly ovate, linear, etc.)
6. Leaf cross-section (terete, quadrangular)
7. Leaf angle to stem (erect-ovoid as Haworthia)
8. Leaf margins (spinose, dentate, undulate, entire, lobed, incised)
9. Leaf spine dimensions (length, width)
10. Leaf spine colors
11. Leaf per mature rosette
12. Leaf incurve or recurve (measure leaf bowing in mm or cm)
13. Leaf length (sampled mid-way down the rosette)
14. Leaf width (ditto)
15. Leaf thickness (this is the Z axis or height of the blade)
16. Leaf texture and surface (ie. carunculations in Echeveria, verrucose-zebrinate in Haworthia)
17. Leaf apex (spinose, acute, acuminate, obtuse, arachnoid (spider web), ciliose)
18. Leaf color - apex
19. Leaf color - mid lamina
20. Leaf color - base
21. Leaf color - margin
22. Leaf marking colors (other than those above, such as non-warty or non-raised spots or stripes)
23. Glaucescence rating
24. Vestiture taxonomy (type, color, distribution)
25. Flower/corolla color (more useful in Kalanchoe and Aloe cultivars among others)

Another useful question is this: are there simple but effective tools to take phyllometric data and construct either cultivar groups or natural groups for similarity? The answer is fortunately yes. I took about one hour's worth of Viburnum leaf and flower data, not more complicated than Leaf Length (LLmean), Leaf Width (LWmean), and Inflorescence Width (IWmean) and dropped the data into Microsoft Excel. Using the **Conditional Formatting** function with **Icon Sets**, the following grouping appear of Viburnum cultivars. The first chart shows the **heatmap** or color-shaded values, red the highest, and white the lowest with a pink scale showing intermediates. The icon sets group the range of variation into red, yellow, and green categories, green having the highest value, yellow medium, and red the smallest. The ten cultivars grouped into eight different unique combinations of icon set color. The third chart superimposes a green barchart on the heatmap code for even more visual certainty.

	LL (cm)	LW (cm)	ID (cm)	
2				
3	Cree	14	4	8
4	SPICE BABY	12	6.5	7
5	Nantucket	12	5	12
6	OH CANADA	11.5	10	7.4
7	SHINY DANCER	11.3	7.7	9
8	KILIMANJARO	10.2	4.3	9.2
9	EMERALD ENVY	10	4	12
10	Conoy	6.5	2.5	2.3
11	PEARLIFIC	5.8	2.3	9
12	SNOW JOEY	5.5	2.5	6.9
13				
	LL (cm)	LW (cm)	ID (cm)	
14				
15	Cree	14	4	8
16	SPICE BABY	12	6.5	7
17	Nantucket	12	5	12
18	OH CANADA	11.5	10	7.4
19	SHINY DANCER	11.3	7.7	9
20	KILIMANJARO	10.2	4.3	9.2
21	EMERALD ENVY	10	4	12
22	Conoy	6.5	2.5	2.3
23	PEARLIFIC	5.8	2.3	9
24	SNOW JOEY	5.5	2.5	6.9
25				
	LL (cm)	LW (cm)	ID (cm)	
26				
27	Cree	14	4	8
28	SPICE BABY	12	6.5	7
29	Nantucket	12	5	12
30	OH CANADA	11.5	10	7.4
31	SHINY DANCER	11.3	7.7	9
32	KILIMANJARO	10.2	4.3	9.2
33	EMERALD ENVY	10	4	12
34	Conoy	6.5	2.5	2.3
35	PEARLIFIC	5.8	2.3	9
36	SNOW JOEY	5.5	2.5	6.9
37				
38				

Another approach to Quercus, ornamental or otherwise, is this system used by Liu et al. 2018. Geometric morphometric analyses of leaf shapes in two sympatric Chinese oaks: *Quercus dentata* Thunberg and *Quercus aliena* Blume. *Annals For. Sci.* 75: 90.



Landmark	Description
LM1	junction of the petiole and branch
LM2	junction of the blade and petiole
LM3	blade tip
LM4	base of the apical sinuses of the right - hand leaf apex
LM5	the first lobe immediately above the apex of the right - hand leaf apex
LM6	tip of the lobe at the largest width of the right - hand leaf
LM7	the sinus immediately above the lobes of lm 6
LM8	the first basal lobe of the right - hand leaf, starting from the petiole.
LM9	base of the apical sinuses of the left - hand leaf apex
LM10	the first of the lobe immediately above the apex of the left - hand leaf apex
LM11	tip of the lobe at the largest width of the left - hand leaf
LM12	the sinus immediately above the lobes of lm 11
LM13	the first basal lobe of the left - hand leaf, starting from the petiole

There are actually so many oak phyllometrics papers out there that this link is useful to find many more:

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C47&q=quercus+morphometrics&btnG=

Specific Leaf Area (SLA) is a measure of interest and one that sorts out small vs. large leaved cultivar as well as those with deeper lobing or incisions. There are expensive lab machines to calculate this but there is a useful phone app (see Google Play or Apple AppStore) called Petiole (<http://petioleapp.com/>) which makes this calculation in about a second using an image shot by and stored on one's cellphone. This is obviously much more handy for field work since pressed or dried leaf material can shrink or wrinkle a bit. Because they use a system of downloadable calibration pads, the measurements can be very precise and reproducible. A sample scan is shown below.



The **LeafProcessor** system is worth exploring. An academic study of it appears here:

<https://nph.onlinelibrary.wiley.com/doi/pdf/10.1111/j.1469-8137.2010.03266.x>

and also

<https://www.iff.fraunhofer.de/en/business-units/biosystems-engineering/research/leafprocessor.html>

as are [Leaf-J](#) , [Lamina](#) , and [WinFOLIA](#).

[The conundrum of morphometrics](#) by Jensen is a great paper and leans to the heavier, scientific and mathematical side of the discussion. The literature cited here is a real treasure trove.

What about computer-assisted image matching for leaves? I recently did a test of **Google-based Reverse Image Search**

(<https://www.labnol.org/internet/mobile-reverse-image-search/29014/>) using a Coleus leaf I found in a Google search. I downloaded it with my own name and no URL embedded, I think. It suggested I had *Quercus gambellii*! However, it did pick the website link (1st ranking) of the website the image came from - and I loaded an externally saved copy of the image not their own version. I uploaded an *Acer saccharinum* leaf and it got the species 100% right and showed some other Google images that matched it closely. Well done in this later case. The software easy to fool because when I uploaded an image with the underside of *Magnolia grandiflora* (an image never posted on Google), it interpreted the orangeness to be like a orange flower. I put a dwarf Thuja spray and it came back as Pond Pine. Conifer images don't work very well. In other test, I uploaded a *Cercis canadensis* leaf and it came back as *C. siliquastrum* - not too bad really! I put in a classic *Hedera helix* leaf and it came back as a generic "Houseplant". However, about half the close matches it showed were in the genus *Hedera*. In my last test I updated a red and white *Anemone nemorosa*, not exactly the easiest thing out there. It came back "Poppy Family" but most of it's matching examples were daisies.

Besides using an aluminum, non-deformable ruler for my phyllometrics I often carry a professional, engineering-grade, **carbon fiber, digital caliper** for precise measurements, especiall of small plant parts. It is useful with twig, bud, and petiole thickness values too. Here's a range of them from eBay. I prefer the carbon fibers as they are easy to carry in your pocket over long distances in a garden without being too sharp or heavy. They come in very affordable price ranges these days but the lighter, carbon fiber ones tend to be about \$20.00. You use these for leaf thickness but because of the strength of the caliper it's fairly easily to puncture or otherwise squash a lamina!

(in review)

CHAPTER NINE

TERMINOLOGY OF GARDEN CLONES

These are some useful terms that improve our communication of the variability of cultivars

Monoclonal Cultivar = a cultivar represented by only one clone in the trade, not necessarily the original

Polyclonal Cultivar =

Seed Strain Cultivar =

Mixed Propagation Cultivar =

CHAPTER TEN

SIMPLE CULTIVAR GROUPING FORMS FOR IDENTIFICATION AND CULTIVAR SELECTION

The use abbreviated phrases or groups of letters for cultivar groups is nothing new and has been perfected a time or two.

Let's take a group of plants divided generally by plant size and leaf color, including complex variegation. Hosta will do. There is often a margination color, a central zone color, and the color around these chimeras. We can split cultivars easily as follows:

SGG = small, all gold

SGW = small, gold with white marg

MYB = medium, yellow center, blue next and blue edge

MWB = medium, white center, blue next

MBW = medium, blue center, white margin

MGG = medium, all green

MWGY = medium white center, green innter band, yellow edge

LWG = large, white center, green edge

LGY = large, green center, yellow edge

Pre-identification is what I am calling the limiting of a unknown cultivar or new cultivar to a specific Cultivar Group, botanical form, botanical subspecies, botanical form, or similar infraspecific unit prior to it's assignment, naming, or perhaps outright identification. It is a narrowing now of the

garden ornamental taxon to a set of taxa within a species or generic hybrid group perhaps.

When we formed the **International Coleus Society (ICS)**, the task of writing an iron-clad, perfect cultivar key was and still is considered impossible. It is not and has never been a goal. But can we place cultivars into groups of names with a high degree of precision and confidence? Yes. Firstly we had to develop groups and after some prototyping decided that leaf shape would be the best grouping trait. Color is variable and while there are many leaf shape intermediates, we can define the extremes and therefore define the intermediates all the better. The current cultivar group system from the ICS is found here: http://members.tripod.com/~Hatch_L/coleusclass.pdf

The International Coleus Society (ICS) has several charts, systems, and types of keys to group cultivars, more than 1600 known through history but only about 300-500 around today. **Coleus ID Project Four** is the most recent and is the most basic. We have a name of a known, commercially distributed cultivar, its Cultivar Group by the ICS system, and a description of the leaf colors using the **NOD II Color Syntax** from the New Ornamentals Society. The NOD II or New Ornamentals Database II basically used common color terms in the syntax of [major color] [pattern][secondary color] [shade of secondary color] such as green margined white, green centered dark red, red veined green, yellow mottled red, or chartreuse centered red tinged red. The most complex syntax would have fourth or fifth terms. The following table which is actually a small database of 340 cultivars sold today is sorted by cultivar group then leaf color then name. Any cultivars with the same group and color values are similar or **resemblants**.

Do consider that "red margined green" and "green centered red" are about the same thing, varying with proportions. In this file we emphasize the center color and not the margin color but one can stress either one. Some taxa have more than one color description to improve accuracy. For simplification we only use one Blumei (ovate) group and did not separate the narrow, medium (typical), and large versions of such blades.

Now if I'm looking for a Coleus of the Carefree-Oak shape but in purple this chart gives me four choices such as 'Theatre Velvet', 'Black Dragon' (with a variable pink center), 'Midnight Rambler', and 'Tempest'. If you go to the **ICS Encyclopedia of Cultivars** with now over 1600 names, these four can be sorted out based on the provided descriptions and images, possibly and only some of the time. This ICS reference is often in a live form (regular updates) for society members as well as sold at Amazon in PDF form once a year or so with the new updates.



COLEUS ID PROJECT FOUR

	CULTIVAR	GROUP	COLORS
2	THE WHIRLPOOL	Anemone-Fingered	Chartreuse
1	Yellow Fin Tuna	Anemone-Fingered	Chartreuse
3	Tommy Gun	Anemone-Fingered	Green
4	Amarena (COLISSIMA)	Anemone-Fingered	Green centered orange centered red
5	Molten Coral	Anemone-Fingered	Green centered orange veined red
6	Red Coral	Anemone-Fingered	Green centered pink tinged orange
7	Sea Weed	Anemone-Fingered	Green centered red dark
328	COLISSIMA RASPBERRY	Anemone-Fingered	Green centered red medium
339	Fantastik	Anemone-Fingered	Green centered tinged orange
324	Chirp	Anemone-Fingered	Green centered yellow
311	PROSPECTOR (BE HAPPY)	Anemone-Fingered	Green centered yellow
330	Definitely Different	Anemone-Fingered	Green olive Green veined purple centered purple
8	Fish Net (UNDER THE SEA)	Anemone-Fingered	
9	Gold Anemone	Anemone-Fingered	Purple centered chartreuse

10	Witch Doctor	Anemone-Fingered	Purple centered chartreuse
11	Lime Shrimp	Anemone-Fingered	Purple centered green
13	Rue Boubon	Anemone-Fingered	Purple centered green
12	Witch Doctor	Anemone-Fingered	Purple centered green
14	Lion Fish	Anemone-Fingered	Purple tinged red
15	Gold Anemone	Anemone-Fingered	Red centered yellow
17	LEMON SUNSATIION	Anemone-Fingered	Red centered yellow
16	Macaw	Anemone-Fingered	Red centered yellow
18	Merlin's Magic	Anemone-Fingered	Red dark centered yellow mottled green
19	Kiwi Fern	Anemone-Fingered	Yellow centered purple mottled red
20	Limon Blush	Anemone-Fingered	Yellow mottled green tinged red
21	Yellow Dragon	Anemone-Fingered	Yellow mottled red
319	BRONZE AGE	Blumei	Bronze tinged red
23	Giant Exhibition Limelight	Blumei	Chartreuse
25	LifeLime	Blumei	Chartreuse
24	Versa Lime	Blumei	Chartreuse
22	Wizard Golden	Blumei	Chartreuse
26	GATOR GLORY	Blumei	Chartreuse centered orange
27	Fairway Orange	Blumei	Chartreuse centered orange tinged green
28	Juicy Lucy	Blumei	Chartreuse centered orange veined orange
29	Ringleader	Blumei	Chartreuse centered purple violet
30	Red Roof	Blumei	Chartreuse centered red
31	KONG LIME SPRITE	Blumei	Chartreuse centered red dark
312	Be Mine (COLOR CLOUDS)	Blumei	Chartreuse centered red medium
32	GRAN VIA	Blumei	Chartreuse centered red medium
33	TRUSTY RUSTY	Blumei	Chartreuse centered red tinged orange
34	BURGUNDY VELVET	Blumei	Chartreuse centered red veined red
35	Bellingrath Pink	Blumei	Chartreuse mottled pink tinged pink
36	Alabama Sunset	Blumei	Chartreuse mottled red
37	Dexter	Blumei	Chartreuse mottled red
38	Private Dancer	Blumei	Chartreuse mottled red
323	Careless Love	Blumei	Chartreuse mottled red dark
39	Orange King	Blumei	Chartreuse tinged violet backed violet
40	Big Blonde	Blumei	Chartreuse tinged yellow
41	Gays Delights	Blumei	Chartreuse veined purple

42	Coleosaurus	Blumei	Chartreuse veined red
43	Pele	Blumei	Chartreuse veined red
44	Burgundy Gold	Blumei	Chartreuse veined red dark
45	Fairway Yellow	Blumei	Chartreuse veined yellow
46	Fifth Avenue	Blumei	Green centered brown centered pink
47	Butter Crème	Blumei	Green centered cream
48	Wizard Rose	Blumei	Green centered cream mottled pink
49	Miss Monahan	Blumei	Green centered cream mottled red
50	Miss Monahan	Blumei	Green centered cream mottled violet
51	Wizard Coral Sunrise	Blumei	Green centered orange light tinged brown
52	RADICAL WONDER	Blumei	Green centered orange tinged pink
53	Giant Exhibition Rustic Red	Blumei	Green centered orange tinged red
54	Chocolate Covered Cherry	Blumei	Green centered pink tinged brown
55	China Rose	Blumei	Green centered pink tinged purple
56	French Quarter	Blumei	Green centered pink veined red dark
57	KONG ROSE	Blumei	Green centered pink veined red dark
58	Violet Tricolor	Blumei	Green centered pink veined violet
60	Giant Exhibition Magma	Blumei	Green centered purple dark
59	Lord Voldemort	Blumei	Green centered purple dark
307	Artwork	Blumei	Green centered purple dark centered pink
61	BROADWAY	Blumei	green centered red
62	Chocolate Mint	Blumei	Green centered red back green
63	Pink Berry	Blumei	green centered red centered pink
64	VELVETEEN	Blumei	green centered red centered pink
65	Garnet Robe	Blumei	Green centered red dark
67	KONG SCARLET	Blumei	Green centered red dark
68	Mastermind	Blumei	Green centered red dark
66	Wizard Scarlet	Blumei	Green centered red dark
69	Valentine (classic)	Blumei	Green centered red medium
70	Bonifay New	Blumei	Green centered red tinged orange
71	Walter Turner	Blumei	Green centered red veined red
73	KONG JR GREEN HALO	Blumei	Green centered yellow
72	Wizard Jade	Blumei	Green centered yellow
74	Versa Rose to Lime	Blumei	Green centered yellow base red
75	Pink Thrill	Blumei	Green centered yellow mottled pink

306	AMORA	Blumei	Green centered yellow tinged orange
334	Electric Slide	Blumei	Green centered yellow veined pink veined red
305	AMORA	Blumei	Green centered yellow veined red
76	TAPENADE	Blumei	Green live mottled red dark
335	Emerald and Snow	Blumei	Green mottled cream
77	Mighty Mosaic	Blumei	Green mottled green olive mottled red
78	Purple Freckles	Blumei	Green mottled purple
79	Chocolate Splash	Blumei	Green mottled purple dark
80	Ceres (COLSEUM)	Blumei	Green mottled red
81	Giant Exhibition Marble	Blumei	Green mottled red (some bicolor seedlings)
82	SPLISH SPLASH	Blumei	Green mottled red mottled chartreuse
84	Giant Exhibition Marble	Blumei	Green mottled red mottled yellow
83	KONG MOSAIC	Blumei	Green mottled red mottled yellow
85	Indian Summer	Blumei	Green mottled red veined yellow
336	Emerald and Snow	Blumei	Green mottled yellow
86	REBEL ROUSER	Blumei	Green mottled yellow
87	Wizard Pineapple	Blumei	Green mottled yellow tinged red
88	Rose Blast (MOSAIK)	Blumei	Green olive centered red dark centered pink
89	Bronze Pagoda	Blumei	green tinged bronze veined violet red
90	ROYAL GLISSADE	Blumei	Green tinged red veined red
91	Japanese Giant	Blumei	Green upper red lower green
92	Bronze Pagoda	Blumei	Green veined pink centered red
93	Fishnet Stockings	Blumei	Green veined purple
94	ABBAY ROAD	Blumei	Green veined purple dark
95	Flipside	Blumei	Green veined red back red
96	RUBY DREAMS	Blumei	Green veined red medium
97	ELECTRIC LIME	Blumei	Green veined yellow
98	Jo-Jo	Blumei	Green veined yellow
99	Lumen	Blumei	Grene centered yellow
100	Keystone Copper	Blumei	Orange dark
101	Wall Street	Blumei	Orange tinged amber
102	Campfire	Blumei	Orange tinged pink
103	Inferno	Blumei	Orange tinged red
104	Autumn Rainbow	Blumei	Orange tinged yellow
105	Wizard Sunset	Blumei	Orange veined yellow

106	Mariposa	Blumei	Pink centered purple violet
107	Glinda	Blumei	Pink centered red
108	Haines	Blumei	Pink centered red
109	Religious Radish	Blumei	Pink centered red dark
112	Black Jack	Blumei	Purple black
110	Dark Star	Blumei	Purple black
111	Palisanda (Giant Exhibition)	Blumei	Purple black
114	Sorcerer	Blumei	Purple black
115	Vino	Blumei	Purple black
113	Shiny Shoes	Blumei	Purple black
315	Blackie	Blumei	Purple black tinged red
116	Glamboyant	Blumei	Purple dark centered pink magenta
117	Blackberry Waffle	Blumei	Purple dark tinged red
118	Frankies Boltz	Blumei	Purple dark veined pink
119	Grenadine	Blumei	Red centered purple violet
122	Oxblood	Blumei	Red dark
120	Ruby Slipper	Blumei	Red dark
121	Wizard Velvet Red	Blumei	Red dark
123	Big Red	Blumei	Red dark
124	Big Red Judy	Blumei	Red dark
126	Dipt in Wine	Blumei	Red dark base yellow
127	Saturn	Blumei	Red dark centered chartreuse
128	Flamingo	Blumei	Red dark centered pink
129	Grape Expectations	Blumei	Red dark centered pink
130	Empire Red	Blumei	Red dark centered red light
131	Kingwood Torch	Blumei	Red dark centered red medium
132	Morgan Le Fay	Blumei	Red dark mottled pink
133	Redhead	Blumei	Red dark tinged pink
134	VALENTINE (Terra Nova)	Blumei	Red medium
318	BRONZE AGE	Blumei	Red tinged orange (scarlet)
135	Alabama Sunset	Blumei	Red tinged orange mottled chartreuse
136	Christmas Candy	Blumei	White mottled green mottled red
138	Bipolar By Golly	Blumei	Yellow centered green mottled red
137	Pinata	Blumei	Yellow centered green mottled red
139	Copper Glow (Rustic Orange)	Blumei	Yellow centered orange medium

140	Gold Edge	Blumei	Yellow centered orange tinged red
141	Ringleader	Blumei	Yellow centered purple dark
142	Definance	Blumei	Yellow centered red
143	Fire Dragon	Blumei	Yellow centered red
144	Versa Crimson Gold	Blumei	Yellow centered red
145	Beckwiths Gem	Blumei	Yellow centered red dark mottled green
146	Stu Junior (Raspberry Tart)	Blumei	Yellow centered red medium
147	Shocker	Blumei	Yellow centered red veined red
148	Dappled Apple	Blumei	yellow mottled green
149	REBEL ROUSER	Blumei	Yellow mottled green
150	Serenade	Blumei	Yellow mottled green mottled red
151	Freckles	Blumei	Yellow mottled orange
321	Candy Strove	Blumei	Yellow mottled pink
152	Finger Paint	Blumei	Yellow mottled red
322	Candy Strove	Blumei	Yellow mottled red tinged pink
153	Gold Compact (Gold Compacta)	Blumei	Yellow tinged red
154	Florida Inferno	Blumei	Yellow veined red
155	Gold Compact (Gold Compacta)	Blumei	Yellow veined red (some stock)
156	Penny	Blundi	Yellow tinged orange tinged red
157	Brownie Points	Carefree-Oak	Amber tinged brown centered red
158	Brownie Points	Carefree-Oak	Brown tinged gold centered red
326	Cinderella	Carefree-Oak	Chartreuse
159	El Brighto	Carefree-Oak	Chartreuse centered pink centered red
160	Sizzler	Carefree-Oak	Chartreuse mottled red
161	Sultana	Carefree-Oak	Chartreuse veined red dark
162	Rattlesnake	Carefree-Oak	Cream mottled red mottled green
163	Watermelon	Carefree-Oak	Green centered pink veined pink
304	Abigail	Carefree-Oak	Green
164	Wild Lime	Carefree-Oak	Green centered yellow
165	Lemon Chiffon	Carefree-Oak	Green centered pink mottled yellow
166	Sangria	Carefree-Oak	Green centered red veined red dark
167	Lemon Chiffon	Carefree-Oak	Green centered yellow mottled pink
168	Peach Melba	Carefree-Oak	Green centered yellow tinged orange
169	Elfers	Carefree-Oak	Green mottled pink
317	Brazilian Carnival	Carefree-Oak	Green mottled red mottled yellow

170	Alligator	Carefree-Oak	Green olive
171	Abigail	Carefree-Oak	Green olive centered pink
172	SPUMONI	Carefree-Oak	green olive centered red violet
173	Stormy Weather (A)	Carefree-Oak	Green olive mottled red dark
174	Concord Grape	Carefree-Oak	Green tinged purple
175	Hocus Pocus	Carefree-Oak	Green veined purple dark
176	Songbird	Carefree-Oak	Grene centered red centered pink
177	Elfers	Carefree-Oak	Pink mottled green
178	Gnash Rambler	Carefree-Oak	Pink tinged orange centered purple
179	Theatre Velvet	Carefree-Oak	Purple black
180	Black Dragon	Carefree-Oak	Purple black centered pink
181	Midnight Rambler	Carefree-Oak	Purple dark
182	Tempest	Carefree-Oak	Purple dark
183	Floricolor Holiday	Carefree-Oak	Red centered green
184	Hot Sauce (Tabasco)	Carefree-Oak	Red centered red dark
185	Mississippi Summer	Carefree-Oak	Red medium
186	Pineapple red	Carefree-Oak	Red medium
187	Copper	Carefree-Oak	Red tinged orange (scarlet)
188	Pandora	Carefree-Oak	Red tinged pink
189	Gold Lace	Carefree-Oak	Yellow
190	Collins Gold	Carefree-Oak	Yellow centered green
191	Dutch Mill Drive	Carefree-Oak	Yellow centered green
193	Floricolor Sandstone	Carefree-Oak	Yellow centered green
192	Lemon & Lime	Carefree-Oak	Yellow centered green
316	Blair's Witch	Carefree-Oak	Yellow centered green centered red dark
194	Swallowtail	Carefree-Oak	Yellow centered green centered red dark
195	Desert Sun	Carefree-Oak	Yellow centered green mottled red
196	Paisley Shawl	Carefree-Oak	Yellow centered green mottled red
197	Stormy Weather (B)	Carefree-Oak	Yellow centered green mottled red
198	Stormy Weather (A) Sport	Carefree-Oak	Yellow centered green olive
199	Doctor Wu	Carefree-Oak	Yellow centered green tinged pink
200	Gilda	Carefree-Oak	Yellow centered green veined pink
201	Bonfire	Carefree-Oak	Yellow centered red
333	El Brighto	Carefree-Oak	Yellow centered red centered red dark
202	Solar Flare	Carefree-Oak	Yellow centered red veined green

203	Caracas	Carefree-Oak	Yellow centered red veined red
204	India Frills	Duckfoot	Chartreuse centered red tinged red dark
205	Charlie McCarthy	Duckfoot	Green centered
206	Inky Fingers	Duckfoot	Green centered red dark
207	Cantigny Royale	Duckfoot	Purple dark
208	Purple Duckfoot	Duckfoot	Purple dark
338	Fancy Feathers Copper	Filiform	Green centered orange tinged orange
209	Fancy Feathers Pink	Filiform	green mottled pink mottled yellow
337	Fancy Feathers Black	Filiform	Purple centered pink mottled green mottled yellow
314	Black Lace	Lacerate-Pinnatisect	Green mottled purple black
210	Wasabi	Laciniate-Fimbriate	Chartreuse
211	Tiger Lily	Laciniate-Fimbriate	Chartreuse centered orange tinged red
212	Big Chief	Laciniate-Fimbriate	Chartreuse centered red
213	Crystata	Laciniate-Fimbriate	Green centered cream tinged pink
214	Citron Ruffles	Laciniate-Fimbriate	Green centered cream veined red
215	King Crab	Laciniate-Fimbriate	Green centered red
216	Felix	Laciniate-Fimbriate	Green centered red dark
217	Verschaffeltii	Laciniate-Fimbriate	Green centered red dark
218	Peters Wonder	Laciniate-Fimbriate	Green centered yellow veined red
219	Chewy Rainbow	Laciniate-Fimbriate	Green mottled yellow mottled pink
220	Plum Frost	Laciniate-Fimbriate	Purple centered green
221	Norris	Laciniate-Fimbriate	Purple dark centered pink
222	Norris	Laciniate-Fimbriate	Purple dark veined pink
223	Burgundy Edge	Laciniate-Fimbriate	Red centered chartreuse
224	Henna	Laciniate-Fimbriate	Red centered chartreuse back red
327	Cock of the Walk	Laciniate-Fimbriate	Red centered chartreuse veined red
225	Red Ruffles (clone A)	Laciniate-Fimbriate	Red dark veined red
226	FRILLY MILLY	Laciniate-Fimbriate	Red dark veined red medium
227	Stella Red	Laciniate-Fimbriate	Red medium veined red light
228	Big Chief	Laciniate-Fimbriate	Yellow centered red medium
229	Tammy	Minimalist	Chartreuse centered red
309	AURORA PEACH	Minimalist	Green centered orange mottled brown
230	Tiny Toes	Minimalist	Green centered red
231	Fire Fingers	Minimalist	green centered red centered pink
332	Dirty Martin	Minimalist	Green centered red tinged brown

331	Definitely Different	Minimalist	Green olive
232	Cuckoo	Minimalist	Yellow centered red
233	Tapestry	Monstrose	Green centered red
234	Lenny	Monstrose	Red centered chartreuse mottled orange
235	TWIST 'N' TWIRL	Petticoat	Green mottled red mottled yellow
236	Tilt-A-Whirl	Petticoat	Orange tinged red centered yellow
237	Tilt-A-Whirl	Petticoat	Red centered chartreuse
238	Kingwood Karnival	Petticoat	Yellow centered green mottled red
239	Smallwoods Drive	Petticoat	Yellow centered green mottled red
240	Dianes Gold	Petticoat	Yellow tinged green
241	VELVET MOCHA	Saber-Elliptic	Bronze tinged brown
242	Smokey Rose	Saber-Elliptic	Brown centered pink
243	VELVET MOCHA	Saber-Elliptic	Brown tinged red
244	El Brighto	Saber-Elliptic	Chartreuse centered pink centered red
245	Spiced Curry	Saber-Elliptic	Chartreuse centered red
246	Chipotle	Saber-Elliptic	Chartreuse centered red dark
247	Bright Spark	Saber-Elliptic	Chartreuse centered red medium
248	Zoey (HIPSTERS)	Saber-Elliptic	Chartreuse veined red
249	Apple Brandy	Saber-Elliptic	Green centered red medium
250	Amazon Green (MOZAIK)	Saber-Elliptic	Green centered cream mottled red
251	Pink Poodle	Saber-Elliptic	Green centered pink magenta
308	AURORA BLACK CHERRY	Saber-Elliptic	Green centered pink mottled green
252	Pink Chaos	Saber-Elliptic	Green centered pink tinged red
253	Flora (COLISEUM)	Saber-Elliptic	Green centered red
254	CRANBERRY BOG	Saber-Elliptic	Green centered red
255	CHERRY CORDIAL	Saber-Elliptic	Green centered red dark mottled red
256	Chili Pepper	Saber-Elliptic	Green centered red mottled yellow
257	Red Carpet (MARQUEE)	Saber-Elliptic	Green centered red violet
258	ALLIGATOR TEARS	Saber-Elliptic	Green centered yellow
259	Green Autry	Saber-Elliptic	Green centered yellow mottled yellow
310	AURORA RASPBERRY	Saber-Elliptic	Green centered yellow centered red
260	Sharp Tooth	Saber-Elliptic	Green olive
261	Lava Red (MOSAIK)	Saber-Elliptic	Green olive centered red dark centered pink
262	Thin Mint (MOSAIK)	Saber-Elliptic	Green olive centered red veined red
263	BURGUNDY LACE	Saber-Elliptic	Green tinged red mottled red

264	Habanero	Saber-Elliptic	Orange tinged red
265	Luminese	Saber-Elliptic	Red centered pink magenta
266	COCOA MINT	Saber-Elliptic	Red dark centered green veined red
267	BURGUNDY LACE	Saber-Elliptic	Red tinged green olive
268	Spiced Curry	Saber-Elliptic	Yellow centered red
269	Pineapple Splash	Saber-Elliptic	Yellow centered red veined red
270	Butter Kutter	Salicifolius	Chartreuse
271	Beauty of Lyon	Salicifolius	Green centered cream tinged pink
272	Darth Vader	Salicifolius	Green centered red
273	Fright Night	Salicifolius	Green centered yellow mottled red
274	Combat	Salicifolius	Green mottled red mottled yellow
275	Butter Kutter	Salicifolius	Yellow
276	Combat	Salicifolius	Yellow mottled red mottled green
277	Trailing Black	Suborbicular	Green centered purple black
278	Garnet Robe	Suborbicular	Green centered red dark
279	Trailing Burgundy	Suborbicular	Green centered red dark
320	Brown Sugar Drop	Suborbicular	Green centered red dark tinged brown
280	Burgundy Wedding Train	Suborbicular	Green centered red medium
281	Trailing Dark Heart	Suborbicular	Green centered red medium veined red
282	Avas Grace	Suborbicular	Green veined purple tinged purple
283	Trailing Plum	Suborbicular	Pink centered red
284	Green Lantern	Wide Flat Oak	Chartreuse
285	Wildfire Blaze	Wide Flat Oak	Chartreuse centered red medium
286	Sultana	Wide Flat Oak	Chartreuse veined red dark
303	Abigail	Wide Flat Oak	Green
287	Vanilla Thrilla	Wide Flat Oak	Green centered cream tinged red
329	Cracklin Rosie	Wide Flat Oak	Green centered dark mottled yellow mottled pink
288	Black Magic	Wide Flat Oak	Green centered purple black
289	Red Hot Rio	Wide Flat Oak	Green centered red
290	Apocalypse	Wide Flat Oak	Green centered red dark
313	Big Red (Clone B)	Wide Flat Oak	Green centered red mottled pink
291	Sibila	Wide Flat Oak	Green centered red mottled pink
292	Giant fantasy	Wide Flat Oak	Green centered red violet
293	PARTY TIME LIME	Wide Flat Oak	Green centered yellow
294	Dream Catcher	Wide Flat Oak	Green mottled red mottled yellow

295	Solar Eclipse	Wide Flat Oak	Green mottled red veined red
296	Florida Sun Rose	Wide Flat Oak	pink centered green mottled pink
297	Red Velvet	Wide Flat Oak	Pink centered red dark
298	Hot Sauce (Tabasco)	Wide Flat Oak	Red medium centered red dark
299	Cranberry Sun	Wide Flat Oak	Red veined pink
300	NILE CROC	Wide Flat Oak	Yellow centered green
301	Pinata	Wide Flat Oak	Yellow centered green mottled red
325	Chuluota	Wide Flat Oak	Yellow centered red veined red
302	Eruption	Wide Flat Oak	Yellow mottled red mottled green

My work with *Cercis* involved such a data matrix but I thought one day we needed some new combinations of traits. **The Cercis Polysix Matrix (P6M)** was developed to help this thought process and involved the use of hypothetical combinations. It turns out one of my HYPO ideas was already in the works and Dr. Denny Werner was breeding a golden weeper with plum-toned flowers called 'Golden Falls'. And I never saw coming CAROLINA SWEETHEART™ from Tom Ranney, which blended a variegate and a purple to produce lovely pink, white, and red maculations and wide sectors in a fascinating pattern nor was the purpureo-aurantiac (purple becoming gold) FLAMETHROWER® from Dr. Werner. By the way, J.C. Raulston whose life was cut far too short (tragic, wounding for thousands) would be amazed at these two scholars and scientific craftsman, Werner and Ranney, associated with N.C. State University and JCR's great arboretum, breeding such a vast array of brilliant, useful, and highly creative new woody plants.

The Polysix Matrix or P6M for *Cercis* taxa is a grid of six major traits that have multiple (hence poly) traits or character states. Habit is the first character, varying from narrow-erect to weeping, a continuum of values. The second value is the amount of dark pigments which either produce shades of green or in the extreme red to purple shades. The third value is gold pigments varying from green to rich gold. They may be combined with the green to red/purple continuum to produce coral or orange shades. Leaf gloss is the fourth trait and ranges from a dull, matt-like surface to an extreme luster. Leaf from tiny (about 1.5 in. wide) to huge (10 inches or more) is next. The sixth character trait is corolla pigment or the main aspect of flower color, ranging from none (white) to rich magenta and plum shades. Actual, known taxa are graded here as well as hypothetical taxa which have yet to exist but may some day. By this matrix which is 6 traits with 5 character states each we have 5 to the 6th power possible combinations or 15,625. We don't exactly need that many cultivars so perhaps 300 or so would do over the next century, another 20 or so in the next decade, though I suspect we'll get 50-70 as every nursery wants their own controllable germplasm. A glossy columnar with massive shiny coral-orange leaves and white flowers warms my heart but there are 12,624 more to lust after.

Taxon	Habit	Leaf Purpling	Leaf Gold	Leaf Gloss	Leafsize	Corolla Pigment
	1=erect	1=green	1=green	1=dull/matt	1=tiny	1=white
HYPO=hypothetical future	2=vase	2=medium green	2=lime	2=semi-gloss	2=small	2=pale pink to blush
Selection or hybrid	3=subglobose	3=dark green	3=yellowish	3=medium gloss	3=mid-sized	3=medium pink
	4=arching	4=red/purplish	4=golden-yellow	4=high gloss	4=large	4=rose-red
	5=weeping	5=dark purple	5=gold	5=ultra gloss	5=huge	5=magenta to plum

HYPO: columnar white-flowers, tinyleaf	1	1	1	1	1	1
HYPO: big-leaved purple columnar	1	5	1	4	5	4

DON EGOLF	2	2	1	2	1	5
KAYS EARLY HOPE	2	2	1	2	2	5
CHINENSIS (SHRUBBY)	2	3	1	2	2	5
'Alba' (canadensis)	3	1	1	1	3	1
APPALACHIA RED	3	2	1	1	3	4
CELESTIAL PLUM	3	2	1	2	3	5
TEXAS WHITE	3	3	1	5	2	1
TEXENSIS (DARK FORMS)	3	3	1	5	2	5
RISING SUN	3	4	4	2	3	3
MERLOT	3	5	1	4	3	3
HEARTS OF GOLD	4	1	4	2	3	3
GIGANTEA (PALE FORMS)	4	2	1	3	5	2
CHINGII	4	2	1	2	3	5
GIGANTEA (DARK FORMS)	4	3	1	3	5	3
COVEY	5	1	1	1	4	3
HYPO: gold-leaved weeper, white-flower	5	1	5	4	3	1
HYPO: gold-leaved weeper, plum flower	5	3	1	5	4	5
HYPO: white-flowered weeper, tinyleaf	5	3	2	3	1	1
HYPO: orange glossy weeper	5	4	5	5	4	3
RUBY FALLS	5	5	1	3	4	5
HYPO: weeping dark orange bigleaf	5	5	5	5	5	5

Cultivar	Corolla Color	Corolla Type	Corolla Margin	Leaf Group	Misc	Habit	Origin	Collection
A La Mode	Violet light <u>margin</u> ed white	Double	Semi-undulate	Green ovate		Standard	Swift	
Absinthe House	Pink dark (magenta) tinged darker	Single	Semi-undulate	<u>White-margin</u> ed	Upper petals distinctly darker	Standard	Cookie	
Aca's Ambiblue	Blue dark	Semi-double	Semi-undulate	Green ovate	Dark, <u>redback</u> leaf	Standard	Brownlie	
Aca's Betty Davis	Violet-red dark	Single	Semi-undulate	Green ovate	Dark leaf, star-like petals	Standard	Brownlie	
Aca's Canadian Beauty	Red medium (rose-red)	Single	Undulate	Green ovate	Very near true red – bit pale, rosy	Standard	Brownlie	Ex: Lyon 2010
Aca's Canadian Wonder	Pink medium <u>margin</u> ed white	Semi-double	Undulate	<u>White-margin</u> ed	Quilted variegated leaf	Standard	Brownlie	
Aca's Coral Beauty	Pink medium (coral)	Semi-double	Flat	Green ovate		Standard	Brownlie	BB
Aca's Crime Scene	Red medium (rose-red)	Semi-double	Undulate	<u>Pink-margin</u> ed	Very concave, near true red	Standard	Brownlie	
Aca's Curious George	Blue medium <u>margin</u> ed white	Semi-double	Semi-undulate	Green ovate		Standard	Brownlie	BB
Aca's Daphne	Violet <u>margin</u> ed lilac/lavender	Semi-double	Semi-undulate	<u>White-margin</u> ed		Semi	Brownlie	
Aca's Daphne (record 2)	Violet <u>margin</u> ed lilac/lavender	Semi-double	Semi-undulate	<u>White-margin</u> ed			Brownlie	
Aca's Eloise	White centered violet-red	Semi-double	Semi-undulate	Green ovate	Pale, <u>quilty</u> lead	Semi	Brownlie	BB
Aca's Eye Knees	Pink medium <u>margin</u> ed white	Double	Semi-undulate	Green ovate	Plain, quilted leaf	Standard	Brownlie	Bloomlovers
Aca's Fascination	Pink medium	Semi-double	Semi-undulate	<u>White-margin</u> ed	Diffused, white leaf spots, fading to green	Standard	Brownlie	Bloomlovers
Aca's Flying Free	Pink medium	Semi-double	Semi-undulate	Green ovate	<u>Sticktite</u>	Standard	Brownlie	BB
Aca's Georgine	Pink light <u>margin</u> ed red	Semi-double	Semi-undulate	<u>Pink-margin</u> ed	Reddish margins and streaks	Semi	Brownlie	
Aca's Glamour Puss	Violet-red centered pink	Semi-double	Semi-undulate	Green ovate	Two-tone pansy, mottled and centered	Semi	Brownlie	BB
Aca's Golden Moment	White tinged yellow	Double	Undulate	Green ovate		Standard	Brownlie	Bloomlovers
Aca's Happy Star	Pink dark (magenta)	Single Bell	Flat	Green ovate		Semi	Brownlie	
Aca's Inquisitive George	Violet dark <u>margin</u> ed white	Double	Semi-undulate	Green ovate	Dark leaf, very thin <u>picotee</u> to flower	Standard	Brownlie	
Aca's Johnny Redcoat	Red medium (rose-red) <u>margin</u> ed	Semi-double	Semi-undulate	Green ovate	White tips more than a petal margin	Semi	Brownlie	
Aca's Lady Jane	Pink light tinged lilac-lavender	Single	Flat	Green ovate		Semi	Brownlie	
Aca's Marie	Pink light <u>margin</u> ed green	Semi-double	Semi-undulate	Green ovate		Semi	Brownlie	
Aca's Merry Mary	Red medium (rose-red)	Semi-double	Semi-undulate	<u>Pink-margin</u> ed		Semi	Brownlie	
Aca's Ms. Plum	Violet medium	Semi-double	Undulate	Green undulate	Curiously fluted s-d to single star	Standard	Brownlie	Bloomlovers
Aca's Nicole	Pink light tinged lilac-lavender	Double	Semi-undulate	Green ovate	Wide, open, loosely doubled flowers	Standard	Brownlie	Bloomlovers
Aca's Passionate	Violet dark	Semi-double	Undulate	Green ovate	Dark blade	Standard	Brownlie	BB
Aca's Pink Delight	Pink centered violet-red	Semi-double	Semi-undulate	Green ovate		Standard	Brownlie	Bloomlovers
Aca's Pink Pansy	Pink medium	Semi-double	Semi-undulate	Green ovate	Slightly folded, concave petals, not a pan	Standard	Brownlie	Bloomlovers
Aca's Pink Pet	Pink medium	Semi-double	Semi-undulate	Green ovate	Pretty butterfly-like petals	Semi	Brownlie	
Aca's Raspberry Rapture	Pink medium <u>margin</u> ed violet	Single	Undulate	<u>White-margin</u> ed	Regular leaf edge. Very wide <u>picotee</u>	Standard	Brownlie	
Aca's Red Delight	Violet-red light	Semi-double	Undulate	Green ovate	By no means a true red	Standard	Brownlie	Bloomlovers
Aca's Red Ember	Red dark	Single	Flat	<u>White-margin</u> ed	Very thin white edge	Standard	Brownlie	Bloomlovers
Aca's Red Feather	Red medium (rose-red)	Single	Semi-undulate	Green ovate	Dark <u>redback</u> leaf	Standard	Brownlie	Bloomlovers

PAULI is a free database of more than 2000 cultivars of African violet or Saintpaulia available from Cultivar.org. It was develop to not only describe

the best cultivars but serve as a collection list (see column on the far right). If you care look for a cultivar in "violet dark", semi-double, semi-undulate petals, and a pink-margined leaf there are pull downs to help you select it. This system breaks down cultivars further by habit such as standard, semi, trailing, miniature, and so on. This database follows what is called the **NOD Color Syntax II** developed in the 1990's for the New Ornamentals Database.

There is nothing easier (in theory) and convenient than using a **key to cultivar groups**. It gets you maybe 10-90% of the way to complete, cultivar-level identification depending on the size of the group and similarity of it's member clones. Let's examine Cor van Gelderen's excellent key to the **Cultivar Groups of Acer palmatum**. As you may know, the van Gelderens of the mighty Esveld.nl nursery have one of the largest Acereta on earth. Note than *Matsumurae* and *Amoenum* are usually considered subspecies of *Acer palmatum* as they exist in the wild with similiar traits to the cultivar groups.
https://www.arboretumwespelaar.be/userfiles/file/pdf/180512_Updated%20Japanese%20Maples%20key%20Cor%20van%20Gelderren.pdf

M.H.A Hoffman of Boskoop has taken the Classification of Cultivars to a very high level with his papers on *Weigela*, *Philadelphus*, and *Taxus* (<https://core.ac.uk/download/pdf/29256573.pdf>, <http://natuurtijdschriften.nl/download?type=document;docid=541045>, https://www.lib.teiep.gr/images/stories/acta/Acta%20634/634_11.pdf) going so far as to produce dichotomous keys to the groups. This is an immensely helpful exercise in understanding cultivars and their role in both cultivated plant taxonomic and landscape selection. If this type of classification with clear examples and good group keys could be applied more widely, the life of the horticultural taxonomist and curator would much improve.

CHAPTER ELEVEN

DATA MINING PATENT APPLICATIONS AND FILES FOR CULTIVAR MORPHOMETRICS

The two most familiar and accessible plant patent databases are the [United States](#) and [Canadian](#) systems. There are tens of thousands of cultivars, currently over 30,000 in America, with their measurements of flowers, leaves, habit, stems, etc. This is a treasure trove but it must be mined by hand and not with automation so far.

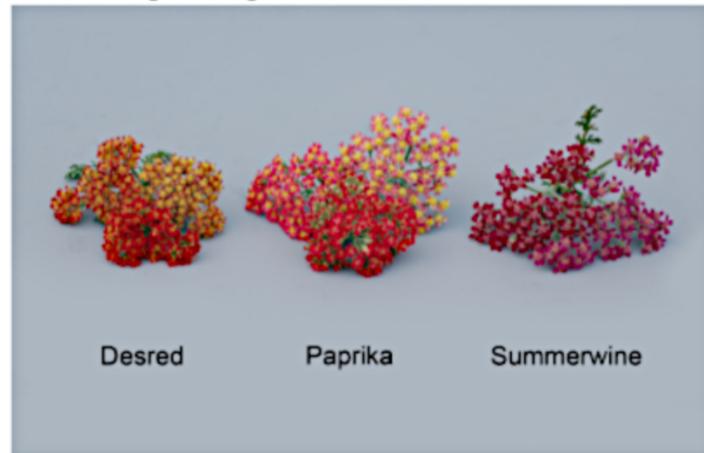
Ray floret: main colour of upper surface (RHS)

	'Desred'	'Paprika'	'Summerwine'
fully opened	darker than 53B	60A changing to 53B-C	redder than 59A
aging to	53B	59D changing to 53D	closest to 71A-70A

Ray floret: colour of lower surface (RHS)

	'Desred'	'Paprika'	'Summerwine'
main colour	11D with N170D at margins	11D with 49C-D at margins	70A-B

Click on image for larger view



Yarrow: 'Desred' (left) with reference varieties 'Paprika' (centre) and 'Summerwine' (right)

This is one example of what the Canadian system does well and that is comparative charts such as this Achillea 'Desred'. If you are a yarrow cultivar taxonomist or expert doing trials, a database from both North American systems will merge nicely with your own color data. Note the qualifiers here like "darker than" and "closest to", a clear sign that the RHS Colour Chart is well...not making the grade in the real gardening world.

Let's be real and practical. For every hour you spent in one of these or other patent databases, you should be able to mine about 10-20 cultivars worth of data for your database. This will take time but in a couple of days you will get a solid core of data of major patented cultivars. Want to get a leg up on this process, go to [Google Patents](#) and download all the US files from the species or genus of interest. Then you can study and extract data at leisure from the PDF files. Since the US system uses "plant named" your searches would be something like "plant named Acer" or "plant named Syringa" (no quotes), also doing the common names too.

In writing my encyclopedia of woody plants, Hatch's Cultivars of Woody Plants, I like to focus in on the **patent comparisons with known, existing cultivars**. The good breeders and creators will compare like to like and not something far off from their creation to make it look special. For example, my former NC State Professor Dr. Denny Werner compared his new Buddleia 'Miss Violet' with these useful notes:

COMPARISON WITH KNOWN CULTIVARS

The closest comparisons known to the inventor are the varieties 'Miss Ruby' (U.S. Plant Pat. No. 19,950) and 'Miss Molly' (U.S. Plant Pat. No. 23,425). In direct comparisons of 'Miss Ruby' and 'Miss Molly' in the inventor's experimental trials, plants of 'Miss Violet' show violet (RHS 83A) flower color, compared to the red-purple (RHS 71B) flower color of 'Miss Ruby'. 'Miss Violet' also shows greater female sterility than 'Miss Ruby'. 'Miss Violet' flower color is distinctly different from the reddish-purple flower color of 'Miss Molly' (RHS 61B). 'Miss Violet' is male sterile (produces no anthers) and is highly female sterile, compared to the high male and female fertility of 'Miss Molly'.

The US Plant Patents have hardly useful black and white images ("drawings") and that is not helpful for taxonomic and other types of cultivar

researchers. But we have two databases which give us the US plant patents with lovely **colorful patent images from the original submissions**. I highly recommend both of these websites.

1. <https://www.lib.umd.edu/plantpatents>
2. <https://www.nypl.org/node/5729>

The Japanese have a very interesting plant patent recording system with some brilliant and useful data on new cultivars. It is rich in their favorite genera like Aucuba and Acer. It is found here:

<http://www.hinshu2.maff.go.jp/vips/cmm/apCMM110.aspx?MOSS=1>

(press English in the upper right hand corner and then enter your search terms)

CHAPTER TWELVE

CYTOTAXONOMY AND GENETICS IN ORNAMENTAL CULTIVARS

I'm going to summarize a few useful papers that have come across my desk in the last few decades.

Ranney, T.G., Lynch, N.P., Fantz, P.R. and Cappiello, P., 2007. Clarifying taxonomy and nomenclature of *Fothergilla* (Hamamelidaceae) cultivars and hybrids. HortScience, 42(3), pp.470-473.

<https://journals.ashs.org/hortsci/view/journals/hortsci/42/3/article-p470.xml>

I'm starting here with one of the favorite hortotaxonomic papers of the century because it's so complete (17 taxa), useful for nomenclature, well-researched, more logical than normal, and all with three highly qualified authors. They combined morphology and flow cytometry to get these integrated results. Hybrid *Fothergilla* provided to be $5x=60$ and that was a very new, useful fact and these given a new name *Fothergilla x intermedia* Ranney and Fantz (*F. gardenii* x *F. major*). The popular cultivar 'Mount Airy' was determined to belong to this hybrid parentage and thus with a new name. Other cultivars were assigned to the correct species also and this was something not always obvious before. They also recorded the accession numbers of their germplasm most from well-curated collections at Yew Dell Garden and North Carolina State University/Raulston Arboretum. No DNA, cytology, or morphometric work is better than the validity and trueness of the selected plant specimens.

Rounsaville, T.J. and Ranney, T.G., 2010. Ploidy levels and genome sizes of *Berberis* L. and *Mahonia* Nutt. species, hybrids, and cultivars. HortScience, 45(7), pp.1029-1033.

<https://journals.ashs.org/hortsci/view/journals/hortsci/45/7/article-p1029.xml>

A solid, modern overview of these two important genera, confirming some *Berberis thunbergii* are tetraploid.

Evans, G.E. and Rasmussen, H.P., 1971. Chromosome Counts in Three Cultivars of *Juniperus* L. Botanical Gazette, 132(4), pp.259-262.

No free public view

They determined that *J. chinensis* 'Hetzii' was an "unexpected triploid".

Hall, M.T., Mukherjee, A. and Crowley, W.R., 1979. Chromosome numbers of cultivated junipers. Botanical Gazette, 140(3), pp.364-370.

No free public view

They determined that *J. squamata* was a triploid in gardens. *Juniperus chinensis* can be diploid, triploid, or tetraploid while *J. virginiana* in gardens is diploid and triploid. Juniper cultivars 'Hetzii' (*hetzii glauca*), 'Blue Cloud', and 'Grey Owl' are all triploid and per their history likely crosses of *J. virginiana* 'Glauca' (diploid) and *J. x media* 'Pfiterziana' (tetraploid). For me this is one of the most important taxonomy papers in all of garden juniper history. They studied 31 cultivars. This paper is not widely known but is the basis for these three major, very important cultivars having a known parentage that is tricontinental from Asian, North America, and Europe. No wonder 'Hetzii' makes such a good, universal rootstock for junipers as it has so much diversity in its cells.

Bowden, W.M., 1957. Cytotaxonomy of *Potentilla fruticosa*, allied species and cultivars. *Journal of the Arnold Arboretum*, 38(4), pp.381-388.

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<https://www.biodiversitylibrary.org/item/33614#page/1/mode/1up>

Being from 1957 this is one of the older, seminal papers sorting out cultivars and other infraspecific by cytological methods. The Arnold Arboretum was still interesting in keep huge, pretty darn near complete cultivar collections and all new sciences would be brought to bear on them. The first thing Bowden did was define the **species sensu lato** (broadest sense) in terms of wild material and also a second popular that represents the species in noted North American collections. Garden material was diploid while some wild material from Sweden and England was shown to be tetraploid. Then he delimited related species which might be considered subspecies or varieties in some modern systems. Then he looks at some cultivars and known garden hybrids. He also found triploids, hexaploids, and octoploids.

Zonneveld, B.J. and Van Iren, F., 2000. Flow cytometric analysis of DNA content in *Hosta* reveals ploidy chimeras. *Euphytica*, 111(2), pp.105-110.

https://www.researchgate.net/profile/Bjm_Zonneveld/publication/225519323_Nuclear_DNA_content_of_ploidy_chimeras_of_HostaTratt_Hostaceae_demonstrate_three_apical_layers_in_all_organs_but_not_in_the_adventitious_root/links/56dd8c9a08aed4e2a99c4f50.pdf

Whether you adore *Hosta* or just variegation or shade plants in general this research will intrigue to be sure. 84 cultivars are studied here. And while I'm at it I should mention that the American *Hosta* Society has done a wonderful job embracing science of this type and quality, publishing it too when other plant societies are content to detail who attended their last tea party with pictures of rich donors.

Rounsaville, T.J. and Ranney, T.G., 2010. Ploidy levels and genome sizes of *Berberis* L. and *Mahonia* Nutt. species, hybrids, and cultivars. *HortScience*, 45(7), pp.1029-1033.

<https://journals.ashs.org/hortsci/view/journals/hortsci/45/7/article-p1029.xml>

The related genera of *Berberis* and *Mahonia* are studied in both species and cultivar form. Among other findings, no tetraploid *Mahonia* were found but one accession of *M. nervosa* was a hexaploid. Tetraploid *B. thunbergii* are common. By the way, Rounsaville's full dissertation can be found here:

<https://reprod.lib.ncsu.edu/bitstream/handle/1840.16/6880/etd.pdf?sequence=2>

Wadl, P.A., Wang, X., Moulton, J.K., Hokanson, S.C., Skinner, J.A., Rinehart, T.A., Reed, S.M., Pantalone, V.R. and Trigiano, R.N., 2010. Transfer of *Cornus florida* and *C. kousa* simple sequence repeats to selected *Cornus* (Cornaceae) species. *Journal of the American Society for Horticultural Science*, 135(3), pp.279-288.

<https://journals.ashs.org/jashs/view/journals/jashs/135/3/article-p279.xml>

Very useful paper covering lots of cultivars.

Some additional papers I hope to discuss in future editions are:

Roberts, D.J. and Werner, D.J., 2016. Genome size and ploidy levels of cercis (Redbud) species, cultivars, and botanical varieties. *HortScience*, 51(4), pp.330-333.

Lattier, J.D. and Contreras, R.N., 2017. Ploidy and genome size in lilac species, cultivars, and interploid hybrids. *Journal of the American Society for Horticultural Science*, 142(5), pp.355-366.

Zale, P.J., Robarts, D.W.H. and Jourdan, P., 2016. Genome size and ploidy levels of creeping phlox and related germplasm of mat-forming taxa from eastern and western North America. *Scientia horticultrae*, 203, pp.53-61.

Eeckhaut, T., Van Huylenbroeck, J., De Schepper, S. and Van Labeke, M.C., 2006, September. Breeding for polyploidy in Belgian azalea (*Rhododendron simsii* hybrids). In XXII International Eucarpia Symposium, Section Ornamentals, Breeding for Beauty 714 (pp. 113-118).

Contreras, R.N., Determann, R. and Friddle, M., 2011. Differences in Winter Browning among Japanese-cedar Cultivars Are Not Due to Variation in Ploidy Levels. *HortScience*, 46(11), pp.1465-1467.

Gupta, P.P., 1978. Cytogenetics of aquatic ornamentals. II. Cytology of Nymphaeas. *Cytologia*, 43(3/4), pp.477-484.

Zadoo, S.N., Roy, R.P. and Khoshoo, T.N., 1975. Cytogenetics of cultivated bougainvilleas. V. Induced tetraploidy and restoration of fertility in sterile cultivars. *Euphytica*, 24(2), pp.517-524.

Ørgaard, M., Jacobsen, N. and Heslop-Harrison, J.S., 1995. The hybrid origin of two cultivars of *Crocus* (Iridaceae) analysed by molecular cytogenetics including genomic Southern and in situ hybridization. *Annals of Botany*, 76(3), pp.253-262.

Zonneveld, B.J.M. and Duncan, G.D., 2003. Taxonomic implications of genome size and pollen colour and vitality for species of *Agapanthus* L'Heritier (*Agapanthaceae*). *Plant Systematics and Evolution*, 241(1-2), pp.115-123.

Brandham, P.E. and West, J.P., 1993. Correlation between nuclear DNA values and differing optimal ploidy levels in *Narcissus*, *Hyacinthus* and *Tulipa* cultivars. *Genetica*, 90(1), pp.1-8.

Saito, H., Mizunashi, K., Tanaka, S., Adachi, Y. and Nakano, M., 2003. Ploidy estimation in *Hemerocallis* species and cultivars by flow cytometry. *Scientia horticultrae*, 97(2), pp.185-192.

CHAPTER THIRTEEN

CLASSIC CHEMOTAXONOMY WORKS AND IS ALIVE AND WELL

There are many papers which impact ornamentals taxonomy from the chemical analysis side and some specific to a group of cultivars. Let's review a few of the best ones.

Fretz, T.A., Cultivars (*Juniperus horizontalis* Moench.). Ornamental Plants--1979 A Summary of Research, p.8.

https://kb.osu.edu/bitstream/handle/1811/70707/1/OARDC_research_circular_n246.pdf#page=8

This was a seminal paper in the modern taxonomy of garden junipers and is a very useful one as Fretz studied terpenes way, way back in 1979.

Crooks, P.K., 1985. Development of a useful procedure for differentiating cultivars of *Juniperus* by volatile terpenoid composition (Doctoral dissertation, The Ohio State University).

https://etd.ohiolink.edu/!etd.send_file?accession=osu1487261553059988&disposition=inline

van Rozendaal, E.L., Kurstjens, S.J., van Beek, T.A. and van den Berg, R.G., 1999. Chemotaxonomy of *Taxus*. *Phytochemistry*, 52(3), pp.427-433.

Taxus are a hot topic and many peoples are being written because of taxols and other compounds of interest in cancer treatments. In this older study many cultivars as well as wild material were studied including the garden *T. x media*. This study also uses 18 measures of morphological comparison as well as the chemistry. The dendrograms of scores of cultivars is a priceless reference. They do one dendrogram for morphology and one for chemistry so comparing the two is quite interesting. The fastigiata *T. baccata* cultivars don't fall out the same way by chemistry!

Santamour Jr, F.S. and Demuth, P., 1980. Identification of callery pear cultivars by peroxidase isozyme patterns. *Journal of Heredity*, 71(6), pp.447-449.

A typical great Santamour paper and unfortunately I can't find a free version link. Here's the abstract:

Electrophoretic analysis of peroxidase isozymes was carried out on leaves and cambial tissue of the *Pyrus calleryana* cvs Bradford, Aristocrat, Chanticleer, Whitehouse, Fauriei and Redspire and for open-pollinated progenies of Bradford and Chanticleer. All the cvs could be distinguished by the presence or absence of peroxidase bands in leaf tissue; only Redspire and Fauriei had identical cambial patterns. With the seedlings, leaf peroxidases were distinct but cambial peroxidases were identical in several cases. All were different from those of the named cvs.

BO, A., HE, É., FARKAS, A., HORVA, G., PAPP, N., LEMBERKOVICS, É. and SZ, É., Chemical and Genetic Relationships among Sage (*Salvia officinalis* L.) Cultivars and Judean Sage (*Salvia judaica* Boiss.).

[Link reduced](#)

Salvia officinalis 'Kew Gold', 'Purpurascens' and 'Tricolor' proved to have very distinct chemical profiles.

Rottink, B.A. and Hanover, J.W., 1972. Identification of blue spruce cultivars by analysis of cortical oleoresin monoterpenes. *Phytochemistry*, 11(11), pp.3255-3257.

Abstract:

The monoterpenes of ten blue spruce cultivars were analyzed to determine the feasibility of chemical identification. There were highly significant differences between cultivars in six of the seven major monoterpenes. Of the 45 possible pairs of cultivars, 37 can be distinguished from each other on the basis of monoterpene composition.

Torskangerpoll, K., Nørbæk, R., Nodland, E., Øvstedal, D.O. and Andersen, Ø.M., 2005. Anthocyanin content of *Tulipa* species and cultivars and its impact on tepal colours. *Biochemical systematics and ecology*, 33(5), pp.499-510.

In floricultural and bulb crops, a study of floral pigments such as flavonoids and anthocyanins can play a big role in cultivar separation. They were even able to pin down cultivars with sometimes less desirable "blue nuances" and "magenta nuances" that are considered less showy.

Borowski, J. and Solecka, M., 1980. Chemotaxonomy of some species of Tilia. Rocznik Sekcji Dendrologicznej Polskiego Towarzystwa Botanicznego, 33, pp.29-36.

Results showed that: one of the parents of *T. × euchlora* is *T. cordata*; *T. × varsaviensis* is not a hybrid but a cultivar ('Varsaviensis') of *T. tomentosa*; *T. petiolaris* is probably a hybrid having *T. tomentosa* as one of its parents; and *T. stellata* [not otherwise specified] shows some relationship to the *T. tomentosa* group. The other species were *T. americana* and *T. platyphyllos* (the most chemotaxonomically isolated).

Lagalante, A.F., Montgomery, M.E., Calvosa, F.C. and Mirzabeigi, M.N., 2007. Characterization of terpenoid volatiles from cultivars of eastern hemlock (*Tsuga canadensis*). Journal of agricultural and food chemistry, 55(26), pp.10850-10856.

Abstract:

The volatile terpenoid fraction from needles in 13 cultivars of *Tsuga canadensis* L. (Carriere) was analyzed by gas chromatography with mass spectrometry (GC-MS). The results of this study are considered along with previously reported results for foliar terpenoid levels of the Asian (*T. sieboldii*, *T. chinensis*, *T. diversifolia*), western North American (*T. mertensiana*, *T. heterophylla*), and eastern North American species (*T. canadensis*, *T. caroliniana*) of hemlock to draw conclusions about the potential of cultivar host resistance to the hemlock woolly adelgid (*Adelges tsugae* Annand). It is suggested that hemlocks in eastern North America have adapted their terpenoid chemistry for protection against endemic defoliators and that this has made them vulnerable to non-native, sucking pests such as adelgids and scales. Some cultivars of *T. canadensis* have a terpenoid profile that resembles that of the resistant noneastern North American species and are candidates for biological screening for resistance. Among the cultivars, the variation in terpenoid chemistry did not absolutely correspond with the considerable differences in morphological characters observed, indicating that the terpenoid chemistry is not definitively coupled with hemlock morphology.

Adams, R. P. and R. E. Riefner, Jr. 2012. Terpenoid fingerprinting to determine an escaped *Juniperus rigida* var. *conferta* identity. Phytologia 94(3): 334-349.

<https://www.juniperus.org/uploads/2/2/6/3/22639912/288.pdf>

This is one of the more bizarre but useful applications of chemotax to cultivars I've seen. It turns out that *Juniperus rigida* var. *conferta* had been spotted growing on the cliffs of Newport Beach, California where it is certainly not a native. Was it planted? Unlikely due to the extreme positions and apparently seedling nature of this population. These two authors determine with terpenoids that the escaped population derived from nearby plantings of 'Blue Pacific' and not the species at large nor the also local cultivar 'Emerald Sea'. **Invasive plant cultivar-level forensics**. How cool.

Wang, Y., Fu, J., Zhang, C. and Zhao, H., 2016. HPLC-DAD-ESI-MS analysis of flavonoids from leaves of different cultivars of Sweet osmanthus. Molecules, 21(9), p.1224.

<https://www.mdpi.com/1420-3049/21/9/1224/pdf>

The Chinese spend a great deal of time and effort on ornamental genera of interest in their gardens. Some of them like *Osmanthus* are finally coming to the attention of American growers though experts here have known of their charms in white, cream, yellow, true orange, sunset, and near red corolla colors for decades. They have also constructed some cultivar grouping systems as well. If you are interested in more papers on these ornamentals visit this Google Scholar link:

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C34&q=osmanthus+cultivar&btnG=

Chemotaxonomy of herbs, many being highly ornamental, is often worked out for us by the originators and other scholars. Plant patents for this new showy herbs often have a chart or two about the chemical differences between new cultivar and other material. Some researchers have gotten

cultivar level taxonomy of herb cultivars down to a fine science. Dr. Arthur Tucker at Delaware State has spend decades working on the chemistry, cytology, morphology, and nomenclature of garden herbs and commercial herbal species. His bibliography has lots of wonderful papers:

<https://cast.desu.edu/about/faculty-profiles/arthur-o-tucker-phd>

One of the better integrated studies of *Mentha* cultivars isthe following paper and it includes morphology as well as chemistry. Anyone who has collected or grown a couple of mints will get new insights from this paper.

Šarić-Kundalić, B., Fialová, S., Dobeš, C., Ölzant, S., Tekel'ová, D., Grančai, D., Reznicek, G. and Saukel, J., 2009. **Multivariate numerical taxonomy of *Mentha* species, hybrids, varieties and cultivars.** *Scientia Pharmaceutica*, 77(4), pp.851-876.

<https://www.mdpi.com/2218-0532/77/4/851/pdf>

The amount of work done on *Lavandula*, almost all highly ornamental, cultivars is staggering. This Google Scholar link will keep us all up to date with a few thousand papers. With these kind of links you get the latest stuff based on the minute you run it.

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C34&q=lavandula+cultivars&btnG=

CHAPTER FOURTEEN

THE ROLE OF FLATBED SCANNERS AND THE "LIVE HERBARIUM"

Quick tip. You can put a live, viable flatbed scanner in your car if you carry a laptop and current invertor to plug the device into your car's plug or cigarette lighter. Yes, that means you can scan a leaf or branch or fruit or flower anywhere you go and even in along an garden, woodland, or arboreta path.

We all know that colors of plants fade when dried and preserved as herbarium vouchers. I do not claim to have invented the "live herbarium" scan because it was done as soon as the technology existed for microcomputers. I do know that I applied it widely to scores of *Hedera* cultivars as early as 2000 with the 'Golden Kolibri' scan shown below. I had nothing good for a background so I used my black leather New Scofield Version of the King James Bible. Besides the color accuracy, especially if one adds a standardized color chip, leaves and shoots do not shrink or change position as much. Fruits do not desiccate and change their shape and colors too.



2000.

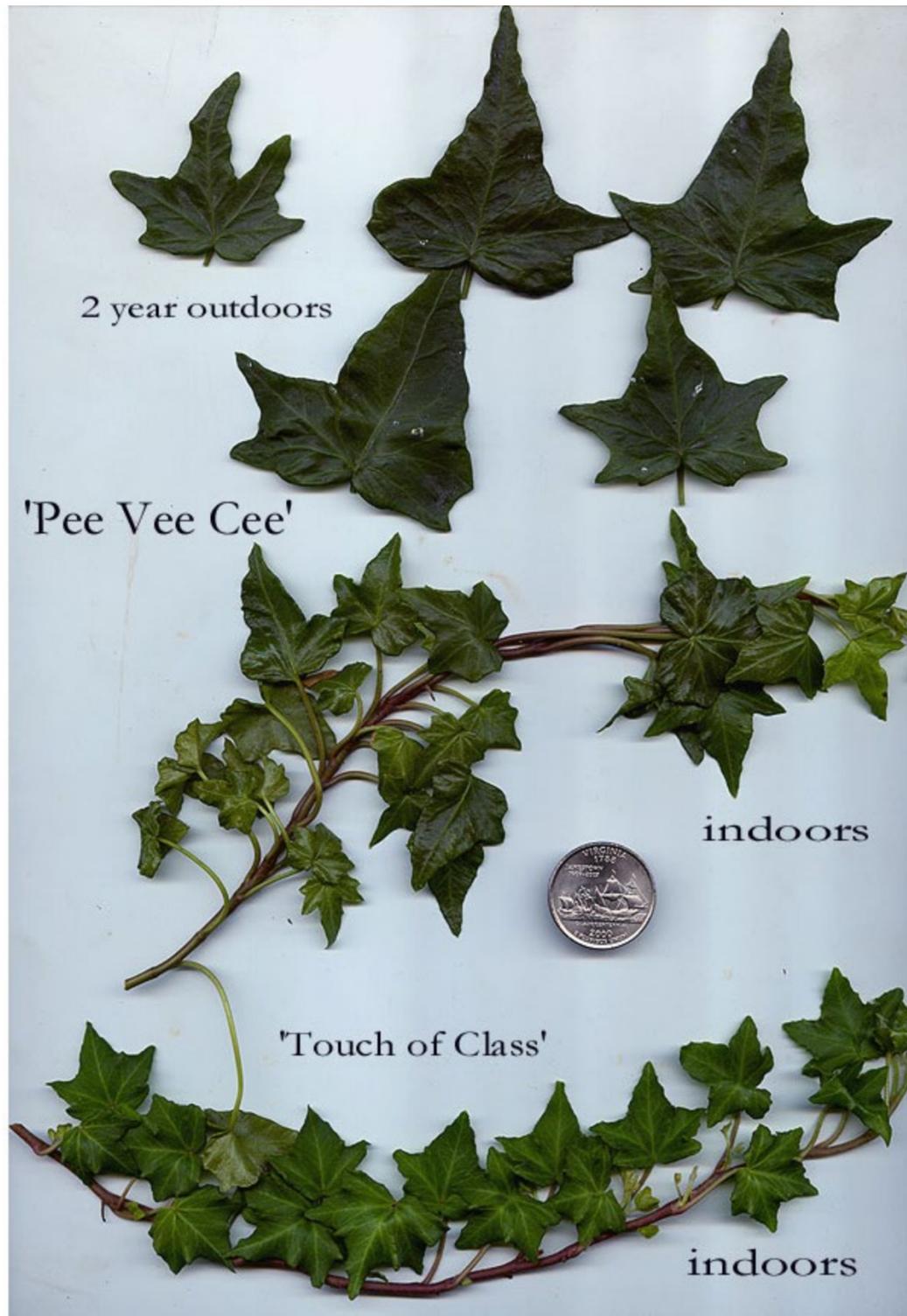
Immediately this type of scan became useful when I had live plants or samples of multiple, **resemblant cultivars** which needed comparing. Still I had no color correction chips nor scale.



Soon the I could not only compare like or resemblant cultivars but I could share the diversity of polymorphic cultivars such as 'Mariposa' with hundreds of unique leaf shapes. The US Quarter was now my very weak but slightly useful measurement of scale.



This tool also become useful when I wanted to compare young, indoor plants to those matured outdoors in the soil, adding one resemblant cultivar to 'Pee Vee Cee' for good measure.



In time it was even possible to stuff entire plants and large sprays, especially among dwarf cultivars into the scanner. I must say I did alot of vacuuming of the desk and floor those weeks. Here is the oddity that is 'Blarney'.

Hedera helix 'Blarney' (fasciated)



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Today the technique is much better with a metal ruler and color chip for comparison.

'Ogre Ears'



'Gollum'



**Crassula
ovata cultivars**

FRILLY SUNRISE

ICS
TRIALS
2017



By the way the flatbed scanner is a great way to share your own, old herbarium. The big guys do this so well and have vast databases full of type specimens and the like. But my own little herbarium, deliberately done on 8.5 x 11 cardstock because I had no space in my high school bedroom was later scanned and now incorporated where useful in Cultivars of Woody Plants among other references. I also have photographs from a Nikon D7000 of this same tree many years later in the CWP.

Laurence C. Hatch
Ornamental Plant Taxonomist



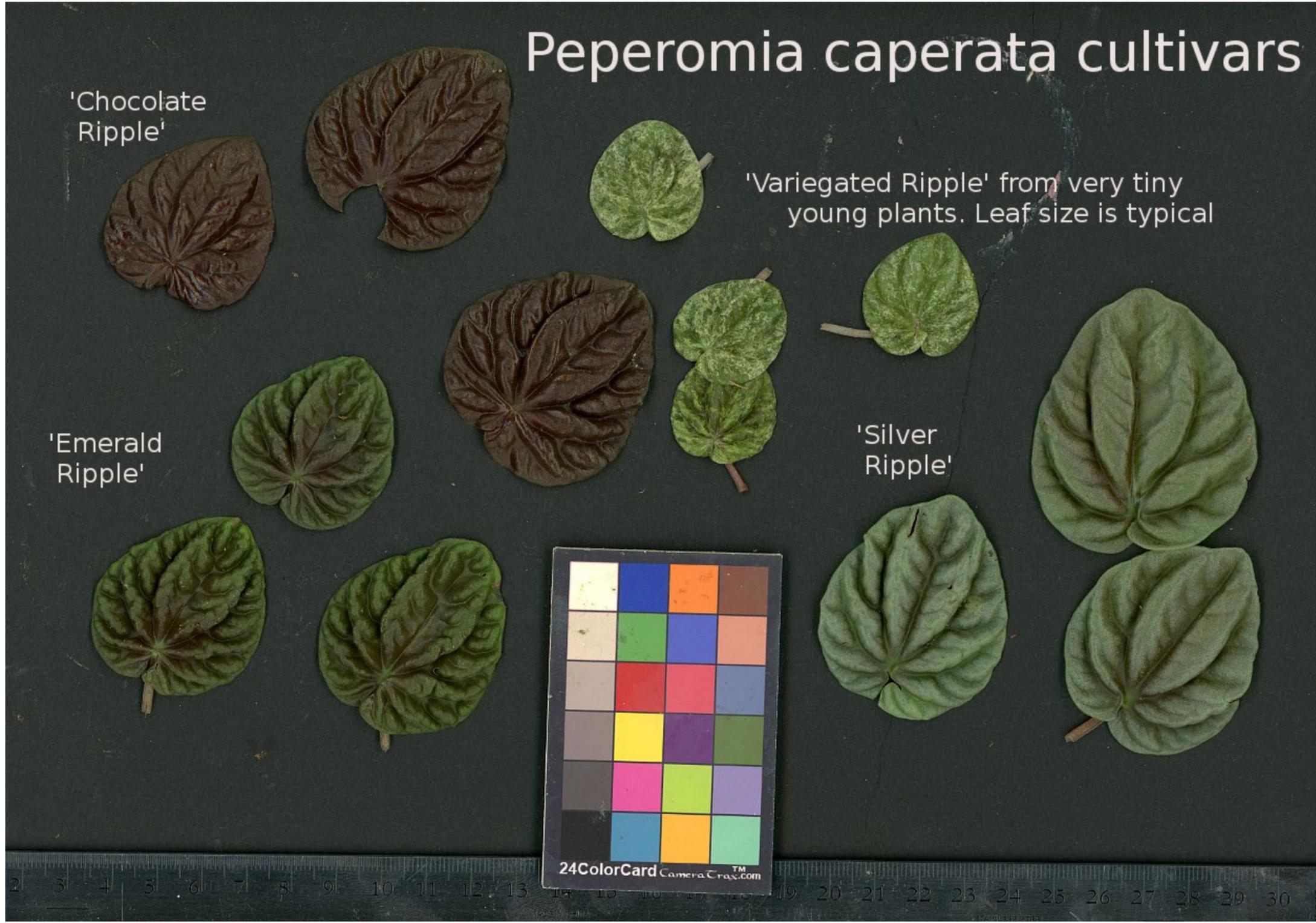
Acer platanoides 'Crispum'
Durand-Eastman Park
Rochester, New York
Summer 1981

From the viewpoint of the ornamentals taxonomist, the best "live herbarium" scans of importance in the woody plant world are those from **Arboretum Wespelaar Database of Illustrations by Jan Le Langhe** and others. This is an amazing treasure trove of taxonomic information and am not sure treasure trove does the thousand of detailed scans of rare material justice. These images are sharp and detailed and can be magnified with ease to get more detail. I dare you. Search for Quercus or Acer and I will predict your head will explode for the richness and quality and depth of these files. It's like a free trip to Europe's greatest arboreta and nurseries in fact. I've been around rare woody plants for five decades and I always find a new taxon or two when I go here:

<https://www.arboretumwespelaar.be/Default.aspx?L=E&WPID=312>

In terms of the larger set of taxa, these are some new and uncommon taxa I scanned for **Hatch's Interior Plants (HIP)**, the largest encyclopedia of interior, foliage, house, and other tropical plants in terms of cultivars. I would like to say it's a good supplement to or follow on from A.B. Graf's *Exotica, Tropica, and Exotic Plant Manual* but frankly we have a ways to go even at 1600 pages offered today in 2019. We're at least trying. I hope as taxonomist you see some value in these feeble efforts to scan and communicate cultivar differences as one step towards a fuller understanding of house plants. I scan warts and all, smudges, and debris, and specks and all. Plants are full of soil, dust, fertilizer, perlite debris, sometimes a mite or two, living tissues, and frankly I don't much trust scans which are too clean and too pure. The metal ruler (which does not flex or warp....much) and

the color chip should hopefully let these images be color-corrected, measured and magnified in future years.



**Four Zebrina
pendula
Clones**

'Dark Desire'



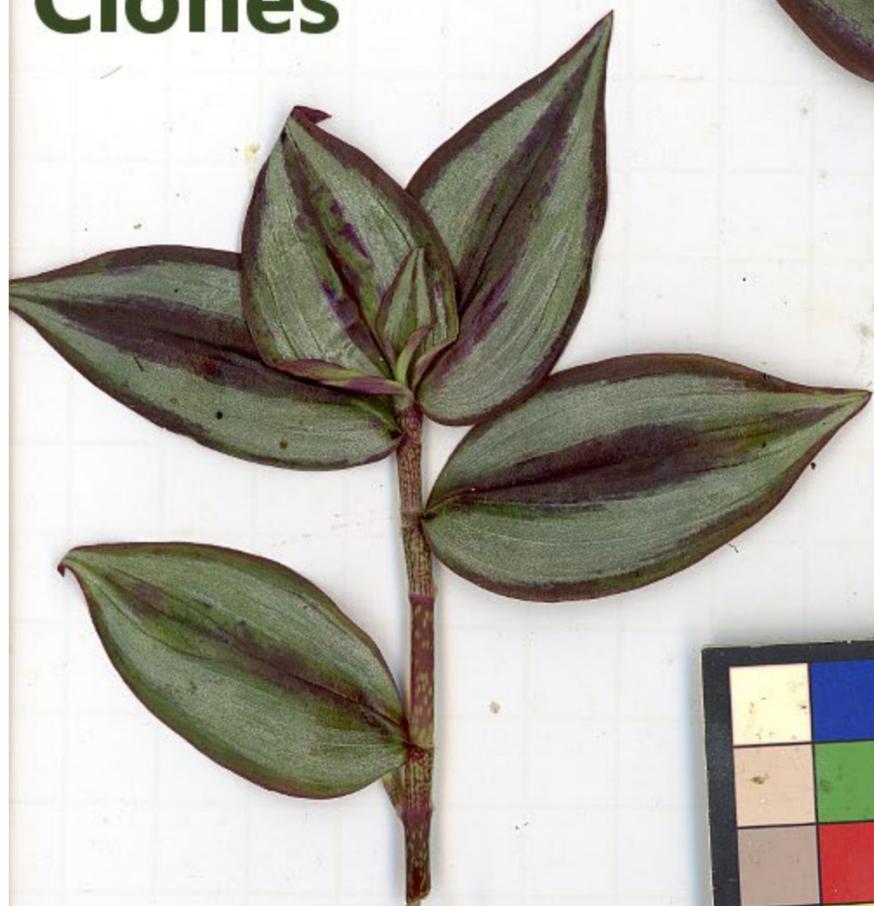
**'Discolor
Multicolor'**



'Discolor'



'Silver Plus'



Pilea aff. hitchcockii 'Dark Mystery'



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www.cultivar.org
Imaged from Cultivar.org
Indoor Trials 2017

24ColorCard Camera Tray.com

Newest tips are bright, glossy
copper to burnt orange

CHAPTER FIFTEEN

CHARACTERIZATION OF LEAF VARIEGATION

Ornamentals taxonomy often involves the study of **resemblant sports** (similar mutations) with chimeral variegation. Most **variegates** (what a variegated taxon is called) were originally described in the 1500 to 1600's as fol. var. for foliis variegatis and sometimes in relation to color, being alba or aurea for white and gold. It was only later that the various patterns were given names to be more expressive as more variegates appeared on the scene. It is perhaps the Ilex mutants that first showed the diversity of patterns possible but it was also true of Cornus and Quercus too. The major **Chimeral Patterns (CP)** we know today are:

1. Maculata (spotted, maculate) - spots, speckled, and zones distributed mostly over the entire blade
 1. White tipped virescent
 2. Gold tipped virescent
 3. Finely maculate
 4. Medium maculate
 5. Coarsely maculate
 6. Sectorial - the chimera in very large sectors, these often being across most of some of the blade, very long, sometimes covering half or more of the entire lamina.
2. Marginata (edged, margined) - the edge a fairly uniform ring of continuous chimera, not interrupted much or in spots
 1. Clean marginata - the margin is mostly a uniform edge or fence of color, little intrusion into the main blade
 2. Insectoring marginata - margin but lots of lines coming from the margin, sectoring into the blade, sometimes to the midrib
3. Marginata-picta - the margin being made up of spots or maculations than form a non-solid or non-continuous ring of markings, not spots in general in the center
4. Medio-picta (centered) - the central zone of the blade being colored, usually in a solid fashion, in a shape (oval, ellipse, linear) but sometimes tree-shaped or even just the midrib wide
5. Medio-maculata - as medio-picta but the center is formed of spotted or maculations distributed only in the center and not on the margins
6. Submarginata (submarginal) - a chimeral band or margin just inside the true margin (this being usually green).
7. Striata (striped, striate) - typical longitudinal stripes along the long axis of the blade
8. Dentata-maculata - a rarer form where only the teeth are colored in a chimera, not a continuous margination at all
9. Apical tip - just a bit of chimera at the apex. (*Aspidistra elatior* 'Akebono')
10. Zebrina (zebra striped, zebrinate) - typically transverse stripes across the leaf
11. Reticulata (reticulate, veined) - chimera or other markings following the major veins
12. Reverse or Intervenal Reticulata - this is where the veins are normal green or species color but intervenal (between vein) areas are chimeral or richly color. *Acalypha wilkesiana* 'Fair Dust' is one such unique, very uncommon example.

Chimeral Color (CC) and **Chimeral Pattern (CP)** are two good places to start with our characterization. These may have several values ranging from the early leaf buds (nodes 1-2), exfurling leaves, mature leaves, and aging or senescent leaves. For example, a **virescent** (becoming green) mutant may have pure white buds, new leaves in white with tiny green spots, mature leaves of a mix of half green and half white markings, and very old leaves mostly green with some whitish to cream markings. One of the most useful descriptors and this is one I emphasize in my encyclopedias is **Chimeral Surface Percentage (CSP)**. Cultivar A has a 8-15% maculation or spotting while Cultivar B has more chimera and bolding at 30-45%. Chimeral dimensions (CD) is also helpful such as "white to cream margins 2-5mm wide", "yellow central zone 10-15mm long x 3-6mm wide", and "spots 4-8 mm wide, occasional sectors much larger at 10-17mm wide or long".

There are **leaf image analysis tools** which measure the amount of tissue damage (ie. dark or pale spots) on a leaf and this might be applicable to getting very accurate CSP numbers with variegated. Just a thought but don't have the right software yet.



many groups like Bromeliads, Sansevieria, and Coleus **Chimeral Overlays (CO)** are important to study and especially the interaction of those non-chimeral colors with the true chimera. Aechmea often have zebrinate or transverse bands of silver as do many snakeplants along with a central or marginal chimera. Many bromeliads as well as Coleus have marginally pigmented teeth that alter our perception of the chimera. In Coleus these overlays can be such traits as red veins into the chimera, brown dots, or dusky purple overlays.

Maculation Distance (MacD) is the measurement, usually in millimeters between spots, especially useful in cultivar sets where the spots don't fuse or overlap as much and are fairly sparse.

of spreadsheets and small databases to record a matrix of cultivar data is a good place to start when first approaching a cultivar-level taxonomy. It is also able to mature as you gain years of data and add more samples of more taxa. Start with the main traits you think might be useful such as flower color, flower doubleness, flower width, height of plant, and width of plant as one example. Measure more and more things and eventually you'll get to a data matrix that helps group cultivars based on phenotype and perhaps can serve to identify them from time to time.

CHAPTER TEN

SIMPLE CULTIVAR GROUPING FORMS FOR IDENTIFICATION AND CULTIVAR SELECTION

The use abbreviated phrases or groups of letters for cultivar groups is nothing new and has been perfected a time or two.

Let's take a group of plants divided generally by plant size and leaf color, including complex variegation. Hosta will do. There is often a margination color, a central zone color, and the color around these chimeras. We can split cultivars easily as follows:

SGG = small, all gold

SGW = small, gold with white marg

MYB = medium, yellow center, blue next and blue edge

MWB = medium, white center, blue next

MBW = medium, blue center, white margin

MGG = medium, all green

MWGY = medium white center, green inner band, yellow edge

LWG = large, white center, green edge

LGY = large, green center, yellow edge

Pre-identification is what I am calling the limiting of a unknown cultivar or new cultivar to a specific Cultivar Group, botanical form, botanical subspecies, botanical form, or similar infraspecific unit prior to it's assignment, naming, or perhaps outright identification. It is a narrowing now of the garden ornamental taxon to a set of taxa within a species or generic hybrid group perhaps.

When we formed the **International Coleus Society (ICS)**, the task of writing an iron-clad, perfect cultivar key was and still is considered impossible. It is not and has never been a goal. But can we place cultivars into groups of names with a high degree of precision and confidence? Yes. Firstly we had to develop groups and after some prototyping decided that leaf shape would be the best grouping trait. Color is variable and while there are many

leaf shape intermediates, we can define the extremes and therefore define the intermediates all the better. The current cultivar group system from the ICS is found here: http://members.tripod.com/~Hatch_L/coleusclass.pdf

The International Coleus Society (ICS) has several charts, systems, and types of keys to group cultivars, more than 1600 known through history but only about 300-500 around today. **Coleus ID Project Four** is the most recent and is the most basic. We have a name of a known, commercially distributed cultivar, its Cultivar Group by the ICS system, and a description of the leaf colors using the **NOD II Color Syntax** from the New Ornamentals Society. The NOD II or New Ornamentals Database II basically used common color terms in the syntax of [major color] [pattern][secondary color] [shade of secondary color] such as green margined white, green centered dark red, red veined green, yellow mottled red, or chartreuse centered red tinged red. The most complex syntax would have fourth or fifth terms. The following table which is actually a small database of 340 cultivars sold today is sorted by cultivar group then leaf color then name. Any cultivars with the same group and color values are similar or **resemblants**.

Do consider that "red margined green" and "green centered red" are about the same thing, varying with proportions. In this file we emphasize the center color and not the margin color but one can stress either one. Some taxa have more than one color description to improve accuracy. For simplification we only use one Blumei (ovate) group and did not separate the narrow, medium (typical), and large versions of such blades.

Now if I'm looking for a Coleus of the Carefree-Oak shape but in purple this chart gives me four choices such as 'Theatre Velvet', 'Black Dragon' (with a variable pink center), 'Midnight Rambler', and 'Tempest'. If you go to the **ICS Encyclopedia of Cultivars** with now over 1600 names, these four can be sorted out based on the provided descriptions and images, possibly and only some of the time. This ICS reference is often in a live form (regular updates) for society members as well as sold at Amazon in PDF form once a year or so with the new updates.

Members of the **International Coleus Society (ICS)** receive the latest chart known as the **Coleus ID Grid** which shows Cultivar Group vs. Leaf Color in much detail. This is a sample from it and in the society's early days it provided a wonderful way to sort out cultivars by 12 Cultivar Groups and 40 different color patterns or what we call **Color Patterns (COP)** using margin and center color. While we don't yet have cultivars in all the combinations, in theory at least we can segregate the clones into 480 different boxes. That was a good, solid start and we're working to improve in it. By the way, plant breeders can use such charts to determine gaps in phenotype combinations. In the case of Coleus we don't yet have an all red Petticoat nor a red centered green Laciniate-Fimbriate.

CULTIVAR GROUP/ COLOR GROUP (Margin/Center)	(T) Traditional Blumei (ovate) or (N) Narrow Blumei	(W) Wide Blumei (broadly ovate or subor- bicular-ovate)	(Su) Subor- bicular	(Sa) Salici- folius	(T) Trident- Forked	(C) Carefree Oak or (WF) Wide Flat Oak	(F) Fili- form	(A) Anemone- Fingers	(D) Duck- foot	(Mi) Mini- malist	(P) Petticoat	(Mo) Mon- strose	(L) Lacini- ate Fimbri- ate	(LP) Lacera- te-Pinnati- sect
Red (R)	'Redhead', 'Valetine' (TNN not original)	BIG RED JUDY(R)	'Trailing Red' (some green edges)	'Luca'		'Black Drag- on' (some)		None					'Red Ruf- fles' (one clone)	
Red/ Darker Red to Black	WIZARD 'Velvet Red'	'Mariposa' (some)				'Hot Sauce'								
Red/ Green (RG)	'Saturn'								'Mars' (some)					
Red/ Yellow (RY)											'Mint Mocha' (in part)			
Red to Purple/ Pink (RP)						'Smoky Rose'								
Red-Orange-Amber Blend (ROA) – dark not bright orange				'Velvet Mocha'										
Pink/ Red or Black (PRB)	'Religious Radish'	'Haines', 'Mari- posa'												
Red Veined Pink (RVP)		'Kingswood Torch'				'Cranberry Sun' (some)							'Norris'	
Red Veined Pale Red (RVP)		'Stella Red'												
Orange (O)	'Sedona'				None?									
Orange/ Yellow (OY)														
Yellow/Red to Pink (YR)	DEFIANCE GROUP, 'Defi-			'Zooney'		'Solar Flare', 'Bright Spark'					'Marrakesh'			

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1

NOS GLADIOLUS
CULTIVAR CHECKLIST

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3

4	CULTIVAR/TRADEMARK	FLOWER COLOR	MARGINS	HT	DAY	ORIGINATOR	YEAR	MISC	CLAS
5	"1900"	Red striped white	Flat	48		Vaughan?	1903		
6	Aaralyn	Pink dark centered paler	Semi-undulate			Alleman	2007	Tricolor of cream with 2 pink shades	
7	About Face	Pink centered white	Semi-undulate	26	75	Longhenry	2003		
8	Adagio	Yellow medium	Semi-undulate						
9	Addison	Carmine red	Flat				1890		
10	Adi	Red dark centered cream	Flat	34				Feathered cream on lower tepals	
11	Admiral Makharoff	Pink dark centered red	Flat				1906	Slate-colored, scarlet and white marks	
12	Admiral Pierre	Red medium tinged darker	Flat			Lemoine	1903		
13	Adrenalin	Pink light	Semi-undulate						
14	Advance	Red scarlet	Semi-undulate						
15	Adventure	Green <u>margin</u> ed melon	Semi-undulate				1964		
16	African Beauty	Salmon centered paler	Ultra-undulate						
17	After Shock	Red medium centered pink	Semi-undulate					11cm flower	
18	Agnes	White centered red	Flat			Standish	1862		
19	Aguona	Red medium	Semi-undulate			Ciplijauskas			
20	Alaska	White	Semi-undulate						
21	Alba	White	Flat					Better than 'Covillei Albus'	Nanus

Sheet1 Sheet2 Sheet3

NOD II syntax is also used in cultivar.org database of **Gladiolus** cultivars called **GladDB**.

CHAPTER SEVENTEEN

NOMENCLATURAL STANDARDS AND "ORIGINAL INTENT" FOR CULTIVARS

Nobody does nomenclatural standards for cultivars better than the RHS and their impressive program is found here:

<https://www.rhs.org.uk/science/conservation-biodiversity/conserving-garden-plants/rhs-herbarium/nomenclatural-standards>



 Open Viewer

 PDF

 Save Resource

 Collection

 Partner Page

Nomenclatural Standard of *Pterocarya stenoptera* C.DC. cultivar 'Fern Leaf' [family JUGLANDACEAE]

Herbarium Royal Horticultural Society (WSY), WSY0019255

Collection Herbarium Specimens

Resource Type Specimens

Collector Not on sheet, #s.n.

Collection Date 1999/11/16

Country Unknown (Unknown)

Identifications Nomenclatural Standard of *Pterocarya stenoptera* C.DC. cultivar 'Fern Leaf' [family JUGLANDACEAE] (stored under name)

Notes Leaves green (137A), frequently tinged brown/black; veins light green yellow (145A); stem 143A-B-C, base 144A-B, reverse light green

Pages 1

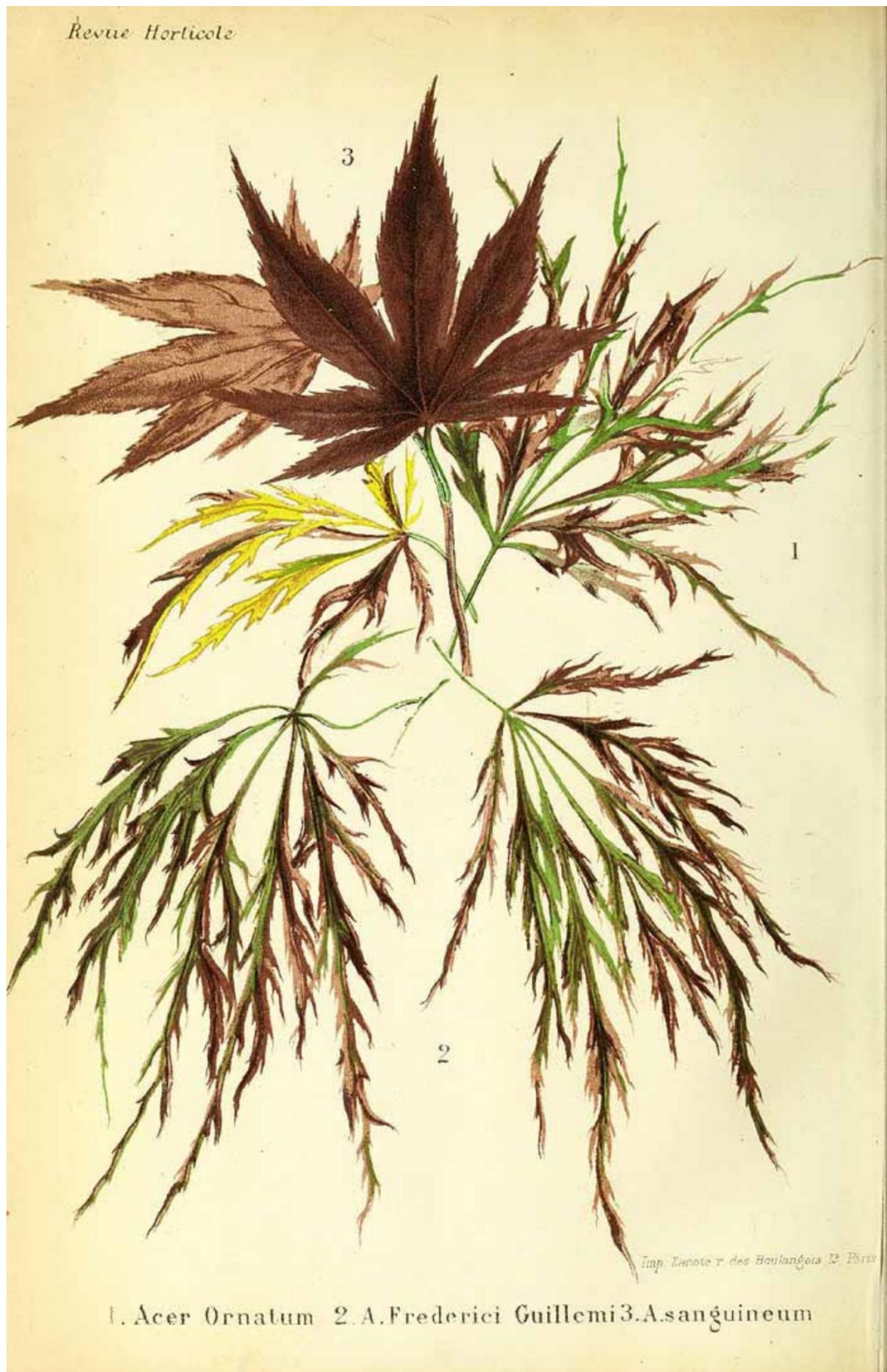
Data last modified 2012-01-03

 View Edit History

Over 2700 of these RHS standards in the form of Wisley herbarium vouchers are found here in scanned format. The cultivars are nicely described, often with RHS color values from the notes on each sheet. An example is shown above. You must have JSTOR access from your institution or pay a \$39.00 annual fee to view the images in larger (that is useful) detail:

https://plants.jstor.org/search?scope=plants&Query=ps_repository%3AWSY+AND+resourceType%3Aspecimens&filter=free_text

The major source of nomenclatural standards as living plants, herbarium vouchers (not all in all cases), image libraries, and scans is with the plant societies, many of which are also **ICRA Cultivar Registrars** (<https://www.ishs.org/sci/icralist/icralist.htm>). Plant societies like the American Ivy Society and American Conifer Society maintain reference collections, the later being distributed all over the US (<https://conifersociety.org/conifers/reference-gardens/>). These are good places to start though many of the ICRA charge large fees for their checklists or the entire set of journals that contain them. The amount of assistance you receive to individual inquiries on a cultivar, member or not, varies from extensive and helpful to "buy our stuff" to no replies at all.



1. Acer Ornatum 2. A. Frederici Guillemi 3. A. sanguineum

Revue horticole by Carriere (1867)

Old botanical illustrations and plates to the extent they are accurate and not too artistic are very valuable as nomenclatural standards, particularly

for older cultivars and **Garden Typical Species (GTS)** as they were known a hundred or two hundred years ago. I have never seen anything close to what was considered *Buddleia davidii* in gardens during my lifetime. Those kinds of plants don't exist in collections for the most part, save those growing wild-sourced material from seed. The best source of old and usually copyright-cleared illustration is www.plantillustrations.org by Max Antheunisse and it's a true treasure trove sorted by genus, species, and even searchable by epithets, authors, and other criteria. It has different layouts for use on phones, tablets, and larger computers. Perhaps most important of all for researchers, the plant names include the original as well as the modern, recognized names of the taxa. If you are looking for old cultivars simply go to each species section and search for var. this or that. Chances are those are cultivars by today's measure. As a cultivar historian I spend hours at Plant Illustrations. To give you a good sample visit their ornamental foliage plant page at http://plantillustrations.org/ornamental_foliage_plants.php?mobile=0&SID=0

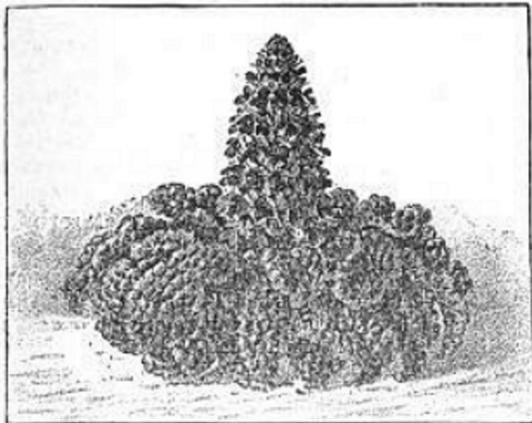


Fig. 13. *Ajuga metallica* var. *crispa* (Lorenz).

Wenn man die oft mehrere Seiten langen Verzeichnisse der Astern-Sorten in den Katalogen der größeren, deutschen Gärtnereien durchsieht, sollte man glauben, dass es den Züchtern kaum mehr möglich sein würde, neue, wertvolle Formen zu erzielen. Nichtsdestoweniger hat man erst vor wenigen Jahren, in der „Riesen-Comet-Aster“ eine Rasse gewonnen, die durch ihre eigenartige, geradezu majestätische Schönheit alle Blumenfreunde überrascht hat.

Digitized by Google

Die Fig. 12 zeigt nun eine Art Gegenstück zu jenen, die Zwerg-Comet-Perfection-Aster, die nur 20 Centim. hoch wird und schon anfangs Juli zu blühen beginnt. Ihre Blütenköpfe sind schneeweiß, atlasglänzend, die einzelnen Zungenblüten lang, breit und leicht gelockt. Die Pflanze bildet schön geformte Büsche und ist daher nicht bloß wertvoll für den Blumenschnitt, sondern auch zur Bepflanzung von Gruppen.

Aus der zu den Lippenblütlern (Labiata) gehörenden Gattung *Ajuga*, Günsel, welche an 30 Arten zählt, die alle außertropischen Gegenden der alten Welt angehören und auch in unserer Flora mehrere allbekannte Vertreter haben (*Ajuga reptans*, *genevensis*, *pyramidalis* u. m. a.), zeigt die Fig. 13 eine wunderhübsche Neuzüchtung aus der Chr. Lorenz'schen Gärtnerei in Erfurt; es ist dies *Ajuga metallica* var. *crispa*.



For years I asked perennial experts about the origin the crisped *Ajuga* variously known as 'Metallica Crispa' among twenty other names. One day doing a deep web Google search I found that it was introduced in Germany by Lorenz in 1899 (scan above). The 1900 Lorenz catalog (which bears the same simple illustration) it was offered in seed packet form which is why perhaps we have at least two variations today, one bronze to purple in new growth, the other very dark green, and perhaps even a third though it's phenotype varies much with vigor and light. The 1900 listing only says dark green and glossy so likely the more purplish-bronze material came later as a cross with 'Rubra' or 'Purpurea' type material.

The ICRA system is flatly broken (though it has some highly functional units) and that is partly why the **Open Registration of Cultivars (OROC)** was created to fill those gaps and offer free registers of new cultivars since 2014. OROC is funded by and affiliated with **Cultivar.org** which like most of the

plant societies charges for its 10,000 PDF page **Cultivar Encyclopedias** in order to fund ongoing research. Some plant specialty groups and plant societies are not affiliated with ICRA and produce their own documents and websites. Having benchmarked our own works, I can say the Cultivar.org encyclopedias have the most number of described cultivars (no worthless name compilations) for 83 different genera, regardless of whether a plant society or ICRA exists for the group. For example, if I may be so frank and accurate, The Maple Society is officially tasked with registering new Acer cultivars but everyone I've asked said they had not gotten around to it. In the interim, and I certainly hope their superior expertise is brought to bear on the issue very soon, OROC has published about 70 recent cultivars of Acer in our free register:

http://members.tripod.com/~Hatch_L/orocwoodyag.pdf. OROC would love to be out of business but until then someone needs to get the data out.

Our friends at **Hortax**, a group of horticultural taxonomists who organize a wonderful guide and resource keep track of free online cultivar registers at the link below.

<http://www.hortax.org.uk/online-registers>

By the way, the **Magnolia Society International** has revised their [free online register](#) with more than 1000 entries (synonyms included) after going about 16 years without much of an update. Awesome work with lots of cultivar detail. Guess somebody sold enough books so this could move forward? Everyone was asking and wondering and whispering.

The **ISU (International Hardy Plant Union)** used to be the official registrar for herbaceous perennials but that sadly went away. They are however coming back strong with their long, detailed trail reports. The images and descriptions are mostly submitted by the originators and so this serves as a nomenclatural standard of the most direct kind. This one of late at 83 MB will surely blow you away:

https://www.isu-perennials.org/en/isu-awards.html?file=files/cto_layout/download/award/sorten/ISU_Trails_2018.pdf

Wateh's Cultivars of Woody Plants

2016-2017 Edition



by Laurence G. Hatch

This would be a good time to mention some of the great **horticultural monographs** out there and a shocking number come from Timber Press as far

as US circulation in concerned. Kudos to them for they have made our knowledge of garden plants much richer and more accurate. These often have helpful plates, original identification keys, highly precise morphological measurements, and instructions on nomenclatural pitfalls. Fiala and Vrugtman (Syringa), Galle (Ilex), Fiala (Malus), Dirr (Viburnum), Vertrees (Acer), van Gelderen (Acer), Batorf (Buxus), Schmid (Hosta), Read (Hippeastrum), Burrell and Tyler (Helleborus), Grenfell (Hosta), Philips and O'Kennon (Crataegus), Krussman (Rosa), Yeo (Geranium), Mathew (Daphne, Crocus, Iris), and White (Daphne) come to mind but there are many others. I have written a couple myself including full cultivar exposes of Aucuba, Juniperus, and Ginkgo that sold separate from the larger CWP.

In modern times we sometimes have very special, detailed articles on cultivar taxonomy which I call **mini-monographs** because of their size, focus, and general lack of a book format. Some of these are stunning and valuable lessons in themselves. Here are two I like very much and they added much to my depth of cultivar knowledge:

- **Alnus cultivars (Jablonski):** https://www.arboretumwespelaar.be/userfiles/file/pdf/180916_Alnus_cultivars_Jablonski.pdf
- **Fagus cultivars (Fortgens):** https://www.arboretumwespelaar.be/userfiles/file/pdf/130915_BDB_Beukenselecties_Fortgens.pdf

I want to talk about the the concept of the **Hybrid Cultivar Register/Monograph concept** as we need more of these. These unlike the typical, traditional cultivar register have full descriptions, images, literature citations, historical notes beyond origin, trial/evaluation reports, nursery source links, nursery catalog scans, phyllometrics, and generally monograph or specialty book topics. The **International Coleus Society (ICS)** when it undertook finding all the named Coleus (formerly, yes formerly Solenostemon), we decided to make our register in this hybrid format. The main reasons were that descriptions of plants like Coleus go only so far. An image is truly worth ten thousands words in some genera. Now over 1600 named cultivars from about 1852 to present, the **ICS Consolidated Cultivar Resource** unites everything we know about each registered cultivar under it's name, all in one place for easy access.



Prunus serrula
'Dorothy Clive'

AGM 2012

Tree size and shape: medium to large tree, 6-8m (20-26ft) high and 4-5m (13-17ft) wide, forming a rounded crown and grown primarily for the colour of its bark.

Flowers: inconspicuous, small white flowers about 12mm (½ in) across are borne in clusters of two to four along with the emerging leaves.

Flowering time: mid to late season.

Foliage: dark green, lance-shaped leaves turn yellow in autumn.

Notes: a selection with glossy, orange-brown bark, paler in tone than 'Branklyn', propagated from a tree growing in the Dorothy Clive Garden, Willoughbridge, Shropshire.

Hardiness rating: H6.

THE FORUM SAID:

'Glossy brown bark that peels like shreds of paper.'

I highly recommend the RHS Wisley Trials Reports and [Grower Guides](#) which contain very detailed measurements and evaluation of cultivars. In some genera and groups of species they are simply the best taxonomic detail we have in literature. A sample of just one of thousands of cultivars evaluated is shown above. These are quite taxonomic at times and often make nomenclatural corrections as they occur in their research. Similarly good and often overlapping and complimentary to the RHS work at the Chicago B.G. [Plant Trials Articles](#).

One of the major sources of original cultivar data in ornamental work are **Official Cultivar Release Notices** which by tradition in the US, Canada, and some other countries often end up being published in [HortScience](#). These are most from universities and non-commercial institutions but sometimes nurserymen come to a university expert to get material published as well. HortScience has been generous in the last few years in making older cultivar releases available at no cost. The new ones are locked but get released soon enough. If you really need a new release visit a local agricultural library or garden and they may have this journal on hand. You can also email the authors after checking their institutional websites for free downloads. Until recently, most universities did not patent their new ornamentals so these things would not usually show up in patent files. Here are just a few samples of HortScience's very useful notices:

- <https://journals.ashs.org/hortsci/view/journals/hortsci/39/1/article-p181.xml?rskey=gkCcIB>
- <https://journals.ashs.org/hortsci/view/journals/hortsci/50/7/article-p1092.xml?rskey=0RzJTL>
- <https://journals.ashs.org/hortsci/view/journals/hortsci/35/3/article-p490C.xml?rskey=cOkVud>

I also recommend university and research station **cultivar release websites** and there are too many to link right now. These often double as **germplasm licensing portals** so growers can access the patented, trademarked, and also unprotected material. One article I find version useful is the [North Dakota State University Woody Plant Improvement Program](#) file. Lots of good, new cultivar descriptions there, 56 woodies to be exact. The largest of them all for ornamentals is most likely the [U.S. National Arboretum Plant Introductions and Releases](#) page. One of the heavyhitters on the herbarous perennial side is Plant Delights and their [PDN Introductions](#) page is very information and simply huge.

I was very impressed by a 26 page presentation called **Verification of Cultivars by Boyce Tankersley**, Director of Living Plant Documentation at Chicago Botanic Garden. This is a wonderful, informative, and colorful introduction to our topic with interesting examples.

<https://community.publicgardens.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=fd6aa3f8-6e4e-4422-fe99-f04e5cb9fdf8>

Tankersley makes reference to **The European Garden Flora**, one of my favorites and a little known reference in the US at least. You may need to visit a specialty, botanical or agricultural library, to view all of it. Amazon.com offered individual volumes of the set from \$49.00 to \$934.00 due to their rarity today. I estimate a good \$4000 for everything that way. I'd love for everyone to have a copy but this is not yet practical. There are some partial (about 20%) previews at [Google Books](#) and I have make photocopies for myself from a nearby university library of about 30 genera that are difficult and of interest. When doing a Google search use a phrase like: European Garden Flora Geum. Use the genus name as you last of four terms and Google Books will find you the right volume. You will find some of the best, updated keys to garden plants in existence and they often so down to major cultivar and cultivar group levels or at least mention them in the context of botanical taxa. These descriptive sections and keys are almost all fresh, original, and done by the top European experts in the genus. Have a look at the distinguished list of contributors:

Contributors

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	P.F. Yeo (University Botanic Garden, Cambridge)

Here's a snip of a key on garden Geum from EGF and a look at one of the hybrid descriptions. Great stuff, especially for herbaceous perennials as I generally prefer Jan de Langhes newer keys for woody genera.

<p>b. Terminal leaflet of basal leaves at least twice size of lateral leaflets 5</p> <p>2a. Plants with creeping non-flowering-stems (stolons); flowers solitary</p> <p style="text-align: center;">1. reptans</p> <p>b. Plants without creeping non-flowering-stems; flowers solitary or to 7 per stem 3</p> <p>3a. Leaflets lobed to at least half their length 4</p> <p>b. Leaflets shallowly lobed 2. elatum</p> <p>4a. Flowers yellow; calyx green 3. rossii</p> <p>b. Flowers cream to purple, never bright yellow; calyx often purple</p> <p style="text-align: center;">4. triflorum</p> <p>5a. Plants with creeping non-flowering-stems; flowers always solitary</p> <p style="text-align: center;">6. uniflorum</p> <p>b. Plants without creeping non-flowering-stems; flowers solitary or to 7 per stem 6</p> <p>6a. Petals dark orange-red to buff-pink; flowers nodding 5. rivale</p> <p>b. Petals yellow, white, cream, bright orange or scarlet; flowers erect 7</p> <p>7a. Lateral leaflets of basal leaves usually less than 5 mm 7. parviflorum</p>	<p>deeply divided lobes. Flowers erect, solitary, c. 3 cm across. Petals yellow, scarcely longer than sepals. <i>European Alps</i>. H3. Summer.</p> <p>G. × rhaeticum Bruggen: <i>G. montanum</i> × <i>G. reptans</i>. Stems to 20 cm, solitary to numerous. Basal leaves pinnate to 25 cm. Terminal leaflet only slightly larger than laterals, heart to wedge-shaped, unevenly lobed. Lateral leaflets in 3–7 pairs, entire or shallowly 3-lobed. Stems-leaves few, small, slender, shallowly lobed. Flowers erect, c. 2.5 cm across. Petals golden yellow. <i>European Alps</i>. H3. Summer.</p> <p>2. G. elatum Wallich. Illustration: <i>Botanical Magazine</i>, 6568 (1881); Polunin & Stainton, <i>Flowers of the Himalaya</i>, pl. 36, 38 (1985).</p> <p>Stems slender and branched, to 35 cm. Basal leaves pinnate to 20 cm. Terminal leaflet usually smaller than largest lateral and similarly shaped, roundish and shallowly lobed. Lateral leaflets in 8–12 pairs, often with small and large pairs</p>
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Sometimes I find nomenclatural standards in odd places such as **herbarium scans of "varieties"** which too us are now cultivars. Most botanical gardens record and scan the vouchers of the garden cultivars on their grounds. These are very valuable scans. The New York Botanical Garden is full of old conifer vouchers such as the following helpful examples, some of them being types.

- Juniperus chinensis 'Luptonii': <http://sweetgum.nybg.org/science/vh/specimen-details/?irn=451645>
- Thuja occidentalis 'Hoopesii': <http://sweetgum.nybg.org/science/vh/specimen-details/?irn=523710>
- ?Juniperus chinensis 'Variegated Kaisuka', possibly ordinary 'Variegata': <http://sweetgum.nybg.org/science/vh/specimen-details/?irn=193749>

One generally finds **herbaria that specialize in specific genera** due to the interest of their scientists. These are ideal standards even if not always types. If you have an interest in a genus contact them and either view the material, online versions thereof, or have your local herbarium borrow material. RHS Wisley has material from their many Plant Trials whereas the U.S. National Arboretum is very rich in Ilex due to cultivar registration, plant taxonomy, and breeding going on there for years (Eisenbeiss, Dudley, Kosar). They are especially rich in Viburnum, Pyracantha, Prunus, and Lagerstroemia from Donald Egolf's work, Magnolia (Kosar), street tree cultivars (Santamour, Townsend) and Camellia (Ackerman). The Royal Botanic Garden at Hamilton is very rich in Syringa due to the collections there and the decades that Vrugtman spent as ICRA.

Some of the **virtual or digital herbaria** searches allow you to specify type specimens and yes that does include botanical varieties and forms now called cultivars. Any Rehder form in the Harvard collection of types is pretty much now a true cultivar. Ilex crenata 'Helleri' as f. helleri Rehder collected by E. Morrell forever tells us what this clone should be:

https://kiki.huh.harvard.edu/databases/specimen_search.php?mode=details&id=136480

There is some debate on the narrow-bladed Aucuba japonica under various names. Here is the type of A.j. f. angustifolia Rehder collected by A. Henry in China. Lots of our modern stuff looks different!

https://s3.amazonaws.com/herbaria2/GPI-Types/HUHGPI00054/Garryaceae/full/full_A00066379.jpg

One good tool that has more cultivars than you'd think is Midwestherbaria.org (vplants.org) which covers twenty of so institutions and some like the

Morton and Chicago B.G. with lots of garden material. Take a look at *Acer palmatum* 'Yasemin' from NYBG in this collection of images:

midwestherbaria.org/imglib/midwest/misc/201504/webmedia_1430410638_web.jpg

or how about 'Seiryu' from Clemson:

https://bisque.cyverse.org/image_service/image/00-zJLghoqUQNvEE75rLdK4rm/resize:1250/format:jpeg

Here's an interesting case. ***Chamaecyparis obtusa* 'Pendula'**. What is it or what was it? The answer is simple. Go to the Kew herbarium page and search for the epithet pendula. It appears to be something on the order of *Chamaecyparis pisifera* Filifera Group. Cones are too large to be *C. pisifera*.

<https://apps.kew.org/herbcat/getImage.do?imageBarcode=K001090472>

Botanical herbarium voucher types are applied to ornamental cultivar material too, especially as so many older ones started as botanical taxa. We continue this trend with cultivars from the start and in my opinion a researcher should make designations with advice of a local herbarium curator. Let's review some of these types:

- Holotype: the one and only one voucher designated by the original author of the name. It is the standard. Period.
- Lectotype: if the original author did not designate or imply a holotype (if prior to 1958), another researcher can designate the best available type or standard.
- Neotype: sometimes the above two are lost or destroyed or badly degraded. A subsequent research can re-type as you will a new, better standard
- Syntype: if the original author left 2 or more specimens but did not designate one a holotype, then more than one sheet can be used collectively as the standard.
- Paratype: the author of the name designates one holotype but also some supporting sheets. These belong here.
- Isotype: duplicates that resemble the holotype and can take over for it should the holotype be lost or destroyed.
- Clonotype: similar to a holotype but a term used sometimes for clonal cultivar material, representing just one original clone.

Here's some practical examples of types applied to ornamental cultivars. I go to the Arnold Arb's page and enter a scientific name, clicking the types box:

https://kiki.huh.harvard.edu/databases/specimen_index.html

I entered *Juniperus* for the genus and *horizontalis* for the species

Up comes Dr. Alfred Rehder's standards for 'Glomerata', 'Plumosa' and 'Douglasii'

'Glomerata' is labeled as the type for var. *glomerata* or f. *glomerata*. It is a true cultivar today.

I hit the clear button (very important for good results)

I enter *Prunus* for the genus and click the types box

Prunus lannesiana var. *amanogawa* collected by E.H. Wilson in 3 syntypes

Today this taxon is known as *Prunus* (Sato-zakura Group) 'Amanogawa'

Clear again.

Enter *Chamaecyparis* for the genus, deliberately no species, click types box

Up comes *Chamaecyparis breviramea* which is what we call *C. obtusa* 'Breviramea' today

This is an isotype by an unknown collector but collected in Yokohama Japan in 1862

It has cones to suggest this species and looked identical to what we seen today.

Clear again. Enter Taxus for genus and click types.

Select Taxus media hicksii collected by Rehder and a holotype

It the legit, original clone as it was traced to AA# 8036 obtained directly from the originator Hicks Nursery, Westbury, Long Island, New York in 1921.

Clear again. Enter Cornus for genus and click types.

Cornus florida f. pluribracteata named by Rehder in 1926

It is the holotype of the first named double-bracted dogwood and traced to the originator Van Lindley Nursery, near Greensboro, North Carolina in 1915

I can go even further and here's a clip of Rehder's pub....

Cornus florida L. f. pluribracteata, f. nov.

"Lindley's New Double Flowering Dogwood," Thos. C. Hunt, 4 pp. 2 ill. Boston (about 1915?).

A typo recedit inflorescentia bracteis 6-8 majoribus et pluribus minoribus instructa, capitulo florum toto vel plus minusve abortivo.

CULTIVATED: Greensboro, North Carolina, *J. Van Lindley*, 1915 (type).

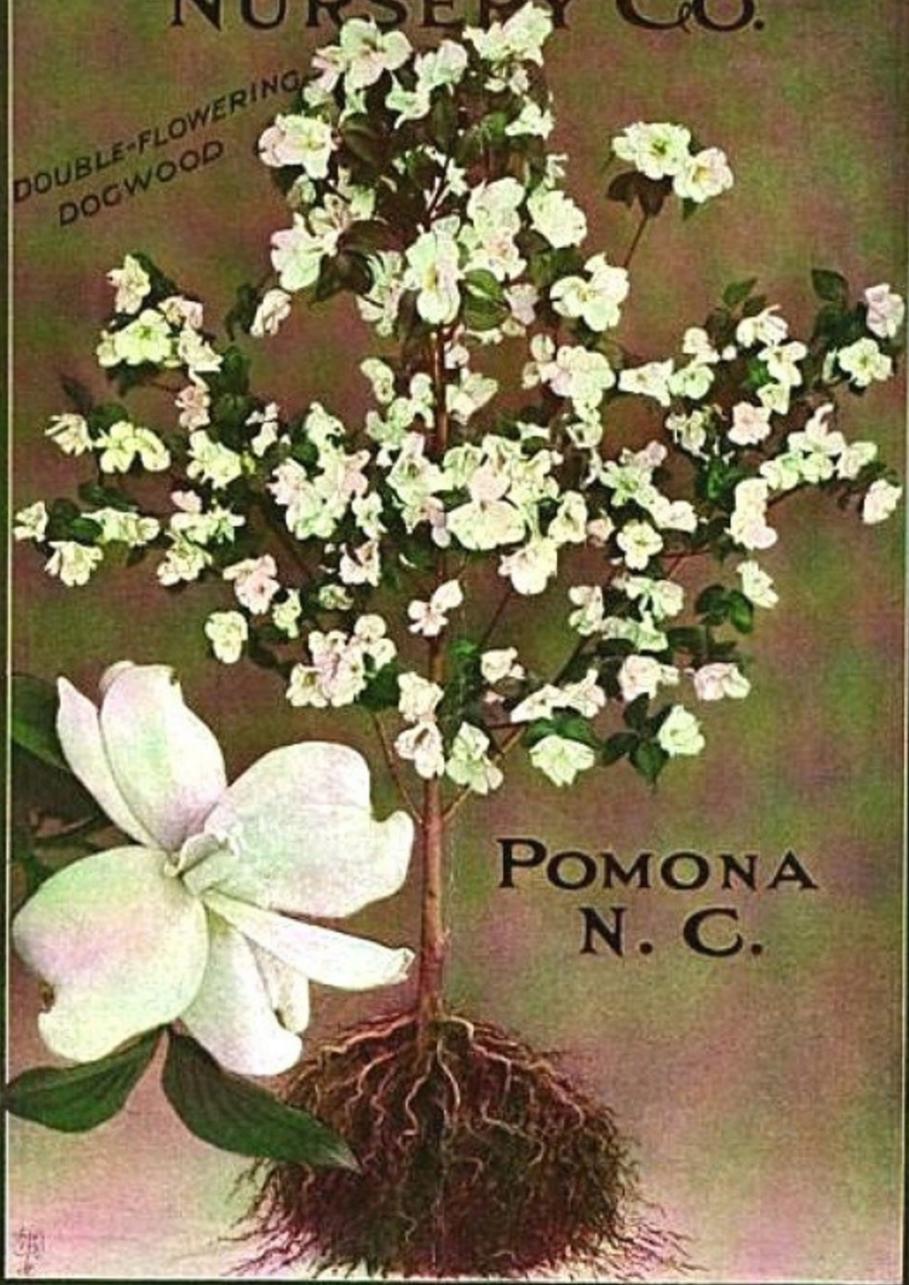
In this form the usual number of four bracts in the typical species is increased to 6-8 and besides there are several smaller bracts in the centre replacing the flowerhead which is nearly or entirely aborted. The bracts are rather large measuring up to nearly 6 cm. in length, and to 4 cm. in width. This form was discovered in Orange County, North Carolina, and propagated by Mr. J. Van Lindley, Greensboro, North Carolina, who sent in 1914 a plant to the Arnold Arboretum which, however, has not yet flowered. This year we received specimens of another *Cornus florida* with

an increased number of bracts but the number of additional bracts is only 1-3 and the head of flowers is normal; this form was collected March 29, 1926, by Mr. Edward Teas in Montgomery County, Texas.

There's even more. I get scans from Lindley's original catalog release. There should be no doubt as to the number, shape, and size of the bracts now that we have several other double dogwoods out there, at least one patented now. There's an arboretum that bought alot of material from Van Lindley and they have an oldish double dogwood in their inventory. I am not going to name them (yet) but there's a good chance this is tracable, surviving clonal material though I don't really think the clone is by any means lost or endangered.

J. VAN LINDLEY
NURSEY CO.

DOUBLE-FLOWERING
DOGWOOD



POMONA
N. C.

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Lindley's New Double-Flowering Dogwood



THROUGH the entire South, and in most parts of the North, the Flowering Dogwood is a familiar object in park plantings and on the grounds of large estates. In the mountain regions of the Blue Ridge system, as well as in other parts of the state, and as far north as Massachusetts, the shrub is found growing wild on the slopes among taller trees and other shrubs. The variety with which we are all familiar is known botanically as *Cornus florida*, although other varieties are grown in ornamental plantings.

Several years ago a gentleman living in Orange County, North Carolina, noticed a small tree of the Dogwood family blooming with others in the woods near his home. The peculiar form of the flowers attracted his attention, and the tree was cared for several years, when it was brought to the attention of Mr. J. Van Lindley, who at once recognized it as an entirely new species of Dogwood.

Propagation by budding began immediately. This work has been continued without interruption until, at the present time, we have several thousand of the little trees in splendid growing condition, varying in height from three to six feet, and with a root-system which will insure successful transplanting to any part of the country where the Dogwoods are grown.

A number of the trees first budded from the parent have been grown under trying conditions, so that we might know whether this new species would prove hardy and satisfactory in low temperatures and in poor soil. These trials have shown the Lindley New Double-flowering Dogwood to be as hardy as the old variety, *Cornus florida*. The newcomer has withstood a temperature of six degrees above zero without losing a twig.

The tree is really a prettier grower than the common Dogwood. When full grown it is from fifteen to twenty feet tall, and unusually symmetrical—the branches forming an almost perfect globe of flowers and foliage. The foliage is similar to that of the other species, dark green on the upper side of the leaf, with a whitish green under-surface. In the autumn the foliage is beautifully colored with scarlet and crimson.

Lindley's New Double-flowering Dogwood is more satisfactory than the old varieties, for it blooms more freely than any of the others. The flowers are pure white, with double center, and larger than those of the old, familiar variety. The engraving of the flower on the opposite side of this page is about two-thirds natural size, but very plainly shows the type of the flower. The tree comes into bloom in April and May, at about the same time as the other Dogwoods. The habit has been carefully observed at each blooming season, and we are sure that the type is thoroughly fixed—all the flowers coming double.

Lindley's New Double-flowering Dogwood grows in shaded places as well as in the full sun, and is not particular as to what kind of soil it is planted in—sand, clay, loam are all the same to this hardy new species. The picture on the other side of this page was made from a two-year-old tree in our nursery, and we want you to notice particularly the straight, tapering trunk, and the form of the head.

The root-system is not an actual photograph, but is the artist's conception, as the photograph was made before the burlap was taken off, the tree having been shipped from Pomona, N. C., to Harrisburg, Pa., in full bloom, in order to get a photograph in actual colors. This is an *average specimen* from the field, and was not selected because of any unusual features. We will fill our orders with trees that are equally good in all respects. Some of the trees, however, were budded higher than others on the stock and have more of a tree effect. You might state which you prefer, high- or low-budded, and we will give it to you if possible.

Ask for quotation on large or small quantities

J. VAN LINDLEY NURSERY CO., Pomona, N. C.

The literature citation of nomenclatural standards and first valid place of publication for a cultivar are two important concepts.

Chamaecyparis pisifera 'Squarrosa'

Retinospora squarrosa Zucc. in Sieb. & Zucc., Flora Japonica, p. 40 (1844) (http://www.ijbotany.com/pdf/JJB_087_326_353.pdf)

Chamaecyparis pisifera var. squarrosa (Zucc.) Beiss. & Hochts. in Gartenflora 1880: 364

The above is fairly traditional, showing that Zuccharini named the cultivar in binomial, species type format, clearly not associating it with *Chamaecyparis pisifera* and for good reason. The name is attributed to this one author and not both because Zuccarini finished the volume after Siebold's death and some portions are thus assigned to him. I went a little extra here by including a link from the Japanese Journal of Botany which actually shows the type voucher. It was later than Beissner and Hoschstetter found the correct species and assigned it as variety, the rank of cultivar not being available then. It was later transferred to cultivar rank but generally we do not care by whom. denOuden and Boom used it as a cultivar but

I am not sure what edition that started it or if that even matters. There was a mass shift of varieties and forms to cultivar rank in the past and it's purely clerical and not worthy of citation in most cases. By the way if all these **botanical author abbreviations** are confusing and not familiar, there are dictionaries such as: [https://en.wikipedia.org/wiki/List_of_botanists_by_author_abbreviation_\(A\)#A](https://en.wikipedia.org/wiki/List_of_botanists_by_author_abbreviation_(A)#A)

It should be remember that technically a cultivar cannot be validly published in a digital, non-print media according to the ICNCP code. That will be of course need to change. It's a silly old principle because with worldwide, international archiving of websites, these resources will last longer than 300-500 year old books that flake away into yellow nothingness. But ironically those books survive in....digital form. I was told by a friend that the RHS was happy with their digital book on cultivars but recommended a printing of 100 copies that would be sold and distributed (perhaps) to libraries for archiving. I find not one copy in U.S. libraries but I'll bet all the RHS libraries have them and they are happy enough with that! I could go ahead and print up 100 copies of my 6455 page Cultivars of Woody Plants to satisfy this kind of thing and have many things suddenly valid. But I don't need that kind of validation as leading curators, authors, researchers and even the U.S. Patent Office cite my cultivar files as in in purely ebook form.

How do we cite digital, ebooks and articles in biographies? The standards are various and if you write for a specific university or institution, they likely have their own standard you need to check. I recommend an article from [Purdue University Libraries](#) which covers many different types of digital citations as shown in the examples below.

- Author, A. A. & Author B. B. (Date of publication). Title of page [Format description when necessary]. Retrieved from <https://www.someaddress.com/full/url/>
- Eco, U. (2015). How to write a thesis [PDF file]. (Farina C. M. & Farina F., Trans.) Retrieved from https://www.researchgate.net/...How_to_write_a_thesis/.../Umberto+Eco-How+to+Write+... (Original work published 1977).
- Spotlight Resources. (n.d.). Retrieved from https://owl.purdue.edu/owl/about_the_owl/owl_information/spotlight_resources.html
- Purdue University Writing Lab [Facebook page]. (n.d.). Retrieved January 22, 2019, from <https://www.facebook.com/PurdueUniversityWritingLab/>
- Author, A. A., & Author, B. B. (Date of publication). Title of article. *Title of Online Periodical, volume number*(issue number if available). Retrieved from <https://www.someaddress.com/full/url/>
- Brownlie, D. (2007). Toward effective poster presentations: An annotated bibliography. *European Journal of Marketing, 41*, 1245-1283. doi:10.1108/03090560710821161
- Davis, J. (n.d.). *Familiar birdsongs of the Northwest*. Available from <https://www.powells.com/cgi-bin/biblio?inkey=1-9780931686108-0>
- Stoker, B. (1897). *Dracula* [Kindle DX version]. Retrieved from Amazon.com

I always like real world examples and I am familiar with some uses of my own digital plant books. Curators tell me that they cite Cultivars of Woody Plants in their databases and those take various formats. The **USNA Checklist of Cercis Cultivars** exists as both a HortScience article (thus valid publication) and as a [website](#) that is 99x more accessible to the people that need it than a periodical costing a great deal of money and then only read by a handful of professionals caring about this topic. While I had my own citations for most of the cultivar names, they cited two of my publications for their reference. It is good to be acknowledged for so many authors have taken my original research and descriptions, ignored any citations, and re-formatted the work as their own. And I know who you folks are, especially the ones using my precise phrases, original measurements, and original research. Digital authors, regardless of their expertise, experience, degrees, and such are often disrespected and abused and frankly plagiarized to a shocking extent and by people who should know better. Kudos to the USNA authors for acknowledging what was best Cercis cultivar study in decades, now with 93 cultivars and 103 total taxa. I thank them for being both realistic and fair.

‘Spring Snow’ (International Register of Ornamental Plant Cultivars: Woody Plants A-Z Book V, 2017): A precocious white-flowered selection of *C. chinensis* listed by Wairere Nursery. Registered in Open Registration of Cultivars online in 2015. Name not yet established because electronic publication does not meet conditions of publication (ICNCP, Article 25).

‘Gold Crown’ (Hatch, Laurence. The Redbuds: Varieties of the Genus *Cercis*. TCR Press. Raleigh, NC. Digital PDF eBook, 2010): Redbud with gold foliage. Name not yet established because electronic publication does not meet conditions of publication (ICNCP, Article 25).

Citation of digital references for new cultivars. In my work I often find it useful to site other digital publications for cultivars. I usually include an accessed on date. Looking some newer taxa, here are some examples of good first citations:

Picea abies 'Bogi' Mesterhazy, Etzelstorfer, and Schneider in [Conifer Treasury](#) of Austria 7.0 (2017), with description and color images, accessed 12.01.2019

Ginkgo biloba 'Clica' American Conifer Society Database, <https://conifersociety.org/conifers/ginkgo-biloba-clica/>, accessed 12.01.2019

Euphorbia pulcherrima 'Amaris Pink' North Carolina State University, Poinsettia Trials Database, <https://trials.ces.ncsu.edu/poinsettias/>, accessed 12.01.2019

Fagus sylvatica 'Brathay Purple' Plantentuin Esveld, <https://www.esveld.nl/html/daen/f/fasbpu.php>, with color images, accessed 12.01.2019

Aesculus flava 'Burning Gold' Dawes Arboretum Plant Explorer, <https://dawesarb.arboretumexplorer.org/taxon-31746.aspx>, accessed 12.01.2019, name only

By the way, the above cited digital references are stunning standardized files for cultivar documentation and all are well worth your time to explore. I may sample these pages for archiving in INCA but never would I distribute them in any way to violate the copyright laws and fair ethics in general. Mr. Mesterhazy ([The Conifer Treasury](#)) is especially generous in allow his massive conifer cultivar files to be downloaded easily in PDF form. He has done stellar, exhaustive work. I would never have his patience in cataloging so many witches broom mutations by name, history, traits, and images. Well done sir!

Hatch's Cultivars of Woody Plants

2018-2020



Laurence C. Hatch
Horticultural Taxonomist

But one can look everywhere for good standards and where I go with my encyclopedia **Cultivars of Woody Plants** and **Hatch's Perennials** is the original descriptions and oldest available images for a cultivar. For example, von Schwerin in 1893 illustrated for the first time the cultivars 'Hessei' and 'Nicholsonii' in clear, accurate detail (see plate below). When I look at modern 'Hessei' in most US collections they lack the distinct dentate teeth and sometimes cut out since nearly 1cm deep. They are merely coarsely to finely serrate and quite different things. That gives me pause as 'Hessei' had been described as an intermediate between typical 7-lobed cultivars and what is today called the Dissectum Group. Absolutely not shown in modern material. This gives me pause and I want to investigate the modern 'Hessei' even more. Some of the Esveld.nl images match these massive, long teeth but most American material, I think, does not. The next question hits us hard: where do we go to standardized living material and perhaps re-clone with a good history back to old material this cultivar in its truest form?

137. Abbildungen zu *Acer palmatum*.



17. *euseptemlobum*.

(Subvar. *septemlobum*.)



18. *sinuatum*.



26. *Hessei*.



28. *Nicholsoni*.



Just a pretty picture to introduce nursery catalogs to our discussion. I don't think there have ever been hollyhock flowers larger than young girl's head but these old catalogs at archive.org are so fun and artistic sometimes.



Original intent for once new cultivars best comes from the originator such as the new Begonia 'Templinii', a true cultivar and not a species, from The Templin Company. It is still in collections but not always with as much silver markings or variegation as shown here. Was this a colorful exaggeration or are the modern plants too weakly marked?

As a cultivar historian a large part of studying North American nursery catalogs is **revising or should I say fixing world cultivar history**. Simply because the dominant German, French, and British authors did not have access to U.S. and Canadian catalogs, so much of European cultivar history is somewhere between incomplete and very wrong; the later being the first appearance of certain phenotypes in Europe when they were already known in the US; or sometimes arose around the same general timeframe. I love Bean, Krussman, and denOuden & Boom but they simply left out more than 140 American conifer cultivars and got some very wrong. There were four different golden Platycladus clones (all distinct) from

Berckman/Fruitland for example. I have sorted these out in CWP if anyone cases. Call their omissions Eurocentric or whatever if you wish. All of us are centered around what we know and can reasonably obtain given our time and resources. They did very well, their best and then some. They simply have no easy or even slightly awkward way to find those names. I have to say the wonderful author and taxonomist Arthur Lee Jacobsen in his **North American Landscape Plants (NALT)** went a long way to fix some of those cultivars omissions. I have found more in recent years, including about 40 more missing cultivars in various woody genera. In doing our checklist of more than 1600 named Coleus, it became very apparent there was a very active, nay thriving American selection scheme and some breeding in the genus that both European and American authors in Coleus seemed to have not noticed. Graf touches on some of this in Exotica but just a few hints. In Coleus selection, hundreds of American clones were named by Dreer (1875-), Manda (1896-), Conard-Jones (1900-), Curry Brothers (1902-1904), D.M. Ferry (1881) Childs (1900), Hoopes (1880), John Dick (1882), Burpee (1893-1902), Saul (1885-1890), Henry Cannell (1895), Jordans (1873), Fruitland (1883), McGregor Brothers (1896), Youngs (1908), and Henderson (1881-1884). Every one knows Manda (formerly Pitcher & Manda) created many useful fern and ivy cultivars, also a famous spider-plant, but of their Coleus work, few are aware.

Let me pause and ask every woody plant expert, horticultural librarian, and especially those in Europe to buy Jacobsen's NALT.

<https://www.amazon.com/North-American-Landscape-Arthur-Jacobson/dp/0898158133>

It's a steal at these Amazon prices and more significantly is the first place of valid publication for more than 200 cultivars not made valid by nursery catalogs. You need it. His original research is staggeringly good and useful. No one other than the great Dr. Frank Santamour of the USNA and [his amazing cultivar checklists \(with A.J. McArdle\)](#) recommended it. I do too. Absolutely a missing and lost book in ornamental taxonomy history for many libraries. And while you're at it do get [Jacobsen's Purpleleaf Plums](#), another overlooked treasure in ornamentals cultivar research.





A few years back the perennial expert Tony Avent sent me this cover image from Plaat's 1934 Phlox catalog. Based on still existing cultivars like 'Juliglut', this appears to be a very accurately colored image not in need of any correction. What a lovely and useful standard for cultivars and they tool much time to get the colors and patterns just right.

NEPHROLEPIS ELEGANTISSIMA COMPACTA

This dwarf, compact form of *elegantissima*, introduced by us in 1909, bears the same relation to that variety that *Scottii* does to *Bostoniensis*. The fronds are considerably shorter than those of *elegantissima*, and it throws a great many more crowns, making it a very bushy, compact, symmetrical plant. It has an ideal habit, and occupies a place by itself, being as distinct from *elegantissima* as that variety is from the original *Piersoni*. While it occasionally throws a few Boston fronds when growth is checked, its dwarf, compact habit makes it particularly desirable. It is especially valuable for growing in small-sized pots, making particularly perfect specimens even in a 4-inch pot.

Plants from 2¼-inch pots, 15c. each, \$1.50 per dozen, \$9.00 per 100; 3½-inch, 50c. each, \$5.00 per dozen; 6-inch, \$1.00 each, \$9.00 per dozen; 8-inch, \$1.50 to \$2.00 each.

NEPHROLEPIS SUPERBISSIMA

This remarkable fern originated with us and was introduced by us in 1908, and is well named *superbissima*, as it is one of the most superb ferns. Its distinguishing characteristics are its dense growth and dark green foliage. The fronds, which are very firm and rigid, are very heavily imbricated, the pinnæ overlapping, making the plants very dense and compact. It is an absolutely distinct variety, not only in the formation of its fronds and its dark green foliage, but also in its habit of growth, which is very sturdy.

Plants from 3½-inch pots, 50c. each, \$5.00 per dozen; 6-inch, \$1.00 each, \$9.00 per dozen; 8-inch, \$1.50 to \$2.00 each.

NEPHROLEPIS HARRISII

This is a very superior and distinct type of the *Boston Fern*, and is similar to that variety except that the fronds are convoluted, or wavy, also broader and more sharply pointed, and the pinnæ are beautifully fluted. On account of its strong growth and long fronds, it is more desirable in the large sizes—say 8-inch and larger—and makes particularly beautiful large specimen plants.

Plants from 6-inch pots, \$1.00 to \$1.50 each.



Nephrolepis elegantissima compacta

When I first ran across the nursery catalogs of F. Pierson and read of all the fern cultivars, mainly in Nephrolepis, they originated, it became apparent I needed copies of those catalogs in preparing **Hatch's Interior Plants** which covers the history of these ferns, new and old. Above and below are just two of a dozen or plates that show plant material in much detail even though there is no color.

Plants from 2¼-inch pots, 15c. each, \$1.50 per dozen, \$9.00 per 100; 6-inch, \$1.00 each, \$9.00 per dozen; 8-inch, \$1.50 to \$2.00 each; extra large specimens, 10-inch, \$3.50 each; 12-inch, \$5.00 each.

NEPHROLEPIS MUSCOSA (The Moss Fern)

This new *Nephrolepis*, introduced by us in 1911, is a sport from *superbissima*, and has the same rich dark color, but the foliage is very fine and moss-like, which suggested the name, this being the distinctive characteristic of the plant. It makes a very beautiful, distinct and refined plant, especially in the small sizes, making most beautiful specimens in small pots. Its distinctiveness and beauty commend it to all plant lovers.

Plants from 3½-inch pots, 50c. each, \$5.00 per dozen; 5-inch, \$1.00 each, \$9.00 per dozen.





In the nursery row, Japanese Juniper make interesting subjects. Given plants of rain and carefully strain they develop into specimens of the most unusual form and character.

Japanese Juniper

Juniperus japonica
(*Juniperus chinensis procumbens*)

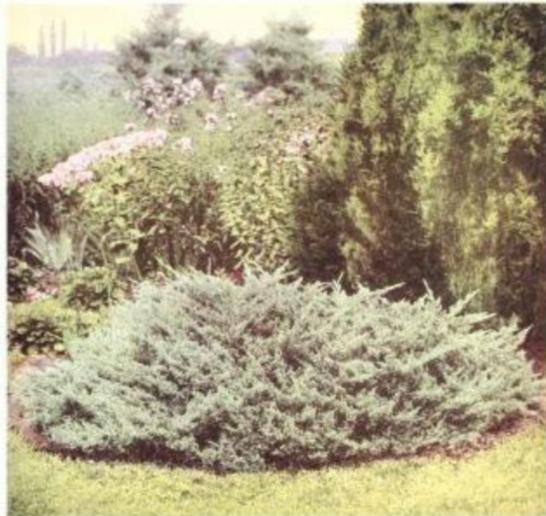
THE following description is taken from a bulletin of the Arnold Arboretum, Harvard University: "This is the best known of the prostrate Junipers which Japan has sent the gardens of America. It is a plant with wide-spreading creeping stems, blue-green. It has sharply pointed leaves marked on the upper surface by two white lines. It is perfectly hardy."

Very old plants will reach 6 or 8 feet in diameter with a height of only 8 to 12 inches. However, it may be permanently kept small by occasional trimming, making it an ideal subject for hanging over rocks, for terraces and low beds of various kinds. It is exceptionally robust, and a strong rugged grower. It thrives in full sun and is one of the low Junipers that will also stand considerable shade.

There is considerable variance among varieties offered as Japonica, but we are careful to propagate by grafting, only from the true strain of hardy compact growing plants we imported direct from Japan many years ago. Here again our customers are given the benefit of our long experience in growing "true to type" specimens.

	EACH	10
10 to 12 inch xxx	B&B \$2.00	\$17.50
1 to 1 1/2 feet xxx	B&B 2.50	22.50
1 1/2 to 2 feet xxx	B&B 4.20	42.50
2 to 2 1/2 feet xxx	B&B 6.00	60.00
*2 to 2 1/2 feet xxx	B&B 8.00	77.50

*Extra choice specimens.



Extra choice plant of Japanese Juniper on the grounds of the Hill Nursery.



Japanese Juniper is well here to good advantage as a low border to a group of Evergreens at an entrance gate. Other trees in this group are: Dwarf Japanese, Weeping Pine and Chinese Chinese Juniper.

Five of the same variety and size of the 10 rate. Each 7 specimens are guaranteed. B&B number 5412 and 5413.

THE SINGING PINE

There's a pine tree on a hilltop,
In a country far away,
Where all the breezes rise and drop,
In the rhythm of their play.

And a steady whispering cloud
In the valley just below,
Lends its measure sweet and low,
To the tall pine's stately flow.

Whether skies of winter darkened,
Or the breezes summer cooled,
Come a little world when harkened,
By those murmuring strains beguiled.

All that warble here has brought her
May warble some day,
But the songs the pine tree taught her,
These shall never pass away.

General Collection.

FOR NEW PLANTS SEE PRECEDING PAGES.

For Prices in quantity for Bedding, see our special Low Price List, sent free on application.

ALTERNANTHERA.

Plants with beautiful variegated foliage, growing about six inches in height; used principally for ribbon lines, borders, etc. The leaves are colored with bright tints, carmine and crimson prevailing.

Paryonchoides Major.—Very much brighter than any other Alternanthera when planted in ribbon lines or masses, giving a bright carmine or rose effect from the time when planted until frost, the hotter the weather, the better the color becoming. This is one of the most valuable bedding plants, because the color is so striking and constant, and the growth dwarf and compact. For carpet gardening it is an essential, as it does not grow over six inches in height. This is a specialty with us, and we can furnish it by the thousand; rates in quantity furnished on application.

Versicolor.—Strong, upright grower, pink and crimson; very distinct and marked.

Aurea Nana.—Originated spring 1882. A sport from "Aurea," upon which it is a decided and marked improvement. It is distinct from and better than Aurea, from its dwarf, dense growth and better color. The habit is as good and about equal to A Paryonchoides, with which it will be valuable to use in ribbon and carpet gardening.

ACHYRANTHES.

All the Achyrantes are now almost indispensable for bedding purposes, either in masses or in the ribbon style; their brilliant tinted leaves forming a marked contrast with all other plants. The following are the best in cultivation, the two first sorts, especially fine for ribboning, etc.

Emersonii.—In general character like Lindenii, but much superior, being very decidedly brighter; color crimson, changing to bright pink. Extra.

Hoveyii.—Broad, pointed leaf with no curl; bright crimson carmine, a splendid bedding sort, as the color is so bright and remains so constantly. We shall grow this in large quantities, as it is extra.

Acuminata.—Broadly pointed leaf, green, with a net-work of golden yellow.

Collinsii.—Beautiful. Leaves narrow, yellow, deeply veined with carmine, with very bright carmine coral stems; habit compact.

Wallsii.—Might better have been styled "Metallica," as the foliage has a dark metallic green lustre. Leaves small, ovate in form; a compact grower, forming an admirable contrast to Var. Stevia or other decidedly white-leaved plants.

8 cents each; 75 cents per dozen.

ASTILBE JAPONICA.

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Alternanthera ficoidea 'Aurea Nana' is a common bedding plant and I can find three or four plantings of it every day on my way to work in 2019. But I wondered where it originated. I was doing a "new plants" (quotation marks essential as I don't want either new nor plants coming up a million times) search at [archive.org's digital catalog collection](https://archive.org's-digital-catalog-collection), this page from F. Pierson in 1885, noting that it originated in spring 1882 as a sport of 'Aurea' and clearly in context of their own selection. Case closed. Score one for the digital age.



In 2000, I started archiving by file saving and later screen capture to PDF and JPG all the nursery catalogs and pages I found useful in my **cultivar history research**, especially introductions of new and rare imported cultivars. It soon became apparent that these pages disappeared quickly, nurseries and specialities went out of business, and the useful data were lost. By ten years out, I calculated that 31% of the content was gone and could not be found on **internet archives sites** which sometimes store old catalogs. Now twenty years later the **INCA (Internet Nursery Catalog Archives)** serves us at cultivar.org very well and we can also find articles, images, and more source material there. Because of the copyrights, virtually none of it, save old documents already on the web anyhow, it cannot be publically shared nor posted. We do work with researchers and have archive partners to keep copies of it on a "new to know" basis that does not violate "fair use" in terms of just a handful of viewers a year and for non-profit

research only. Miss the amazing catalogs of Nursery X and the wonderful articles from Author Y now off the web? We might have them. For one useful example, here is the 2007 set of new Aucuba introductions from Asiatica Nursery (now closed) and this marks the first introduction of these Japanese cultivars to the U.S. and probably the West in general. How Barry Yinger describe them and what did his images look like? INCA provides answers to this and thousands of other questions in cultivar research here at cultivar.org. By the way, the images below and most others can be magnified or blown up to 200-500% with little or no loss in quality because of our capture techniques.



Aucuba japonica 'Daruma' NEW!

Aucuba is a broad-leaved evergreen shrub that will tolerate difficult shaded conditions in the garden; it also makes a beautiful container plant. This rare Japanese selection has small green leaves; the leaves, stems and fruit are variously twisted a...

[More Info]

SKU: #7551 3.5" pot (1) \$50.00 Add to Cart



Aucuba japonica 'Daruma-no-shima' NEW!

Aucuba is a broad-leaved evergreen shrub that will tolerate difficult shaded conditions in the garden; it also makes a beautiful container plant. This very rare Japanese selection is dwarf and congested in growth, with small variegated leaves held in...

[More Info]

SKU: #7514 2.5" pot (1) \$40.00 Add to Cart



Aucuba japonica 'Echigo Nishiki' NEW!

Aucuba is a broad-leaved evergreen shrub that will tolerate difficult shaded conditions in the garden; it also makes a beautiful container plant. This new Japanese variety was found a couple of years ago in Niigata Prefecture, in the wild. It is very...

[More Info]

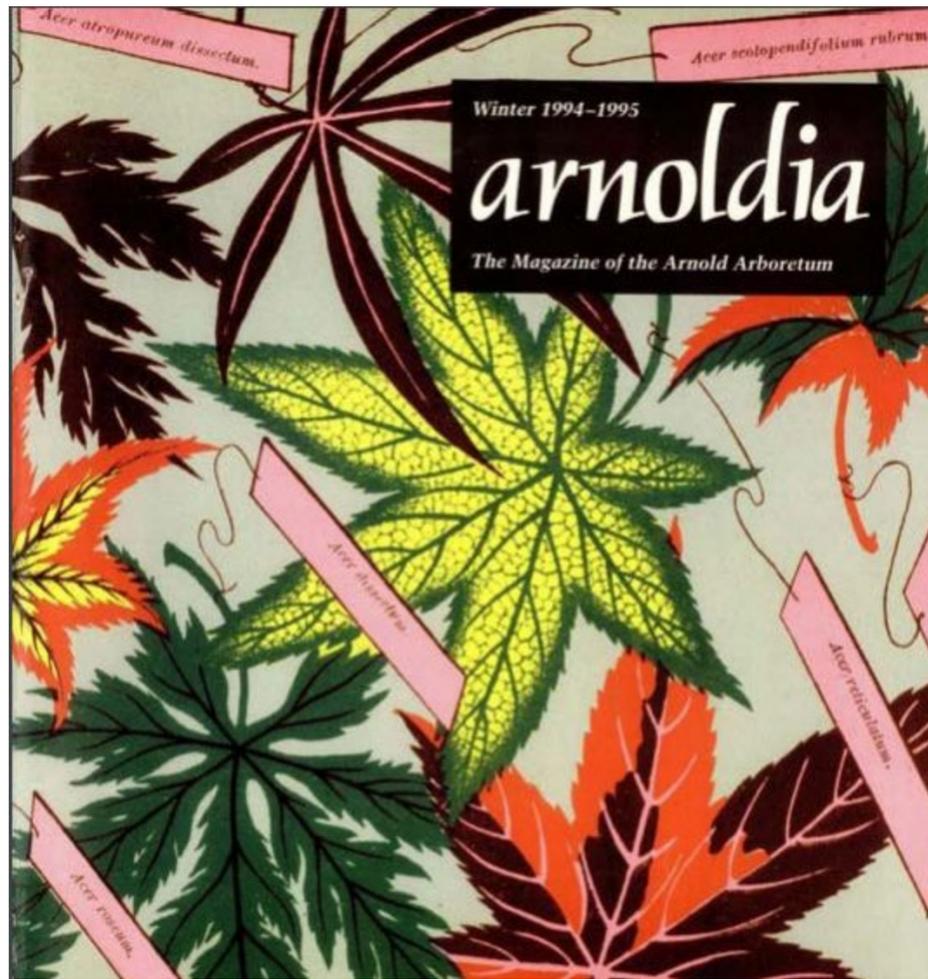
SKU: #7564 2.5" pot (1) \$110.00 Add to Cart



Aucuba japonica 'Fujikawa' NEW!

Aucuba is a broad-leaved evergreen shrub that will tolerate difficult shaded conditions in the garden; it also makes a beautiful container plant. This Japanese selection has the most narrow leaves of any selection. It is a female clone, so it will dr...

If you're a well-known nursery that originates new ornamental cultivars chances are you're on the **INCA capture program** and we'll document your pages or images but not share them in any way that violates a copyright. Right now we have 312 firms on the watch list. If you want to have your catalogs in the INCA system please write the author at the email provided at the top.



There are more **cultivar checklists** in and out of the ICRA system than I can list here. Way back in 1995, Dr. Arthur Tucker, Scott Kunst, Freek Vrugtman and I wrote a checklist of checklist that is fortunately free from Arnoldia:

<http://arnoldia.arboretum.harvard.edu/pdf/issues/1994-54-4-Arnoldia.pdf>

Yes, it's much outdated for the new stuff but in terms of the pre-1995 literature it's quite excellent. I and many other scholar in cultivar history were just starting to put things on the internet in 1995 and my own website through Taxonomic Computer Research called the **New Plants Page** (which is now cultivar.org with 14 million+ pageviews). We thought about doing an update but for various reasons, mostly time and resources, it never happened. In the intervening years, the [Cultivar.org Encyclopedia](http://cultivar.org) grew to over 10,000 8 x 12 or 8 x 16 in. PDF pages. In 2012 I determined that these had the most described cultivars (not just names any fool with a wordprocessor and web access can compile) for 86 genera but linked to the best checklists from many sources such as ICRA for more than 200 other genera. Basically, if they won't do I will with a little help from my friends as time and funds allow. I remember being asked to round up all the Abutilon cultivar names and we figured it might reach 250. More than 550 later we stand today. Named Coleus too total more than 1600 right now. It's always 2-5x bigger a thing than you expect. Cultivar.org has started a thing called **True Cultivar Count™**, our best estimate for the total number of cultons (cultivars plus cultivar groups and other units) and it's published here and there, often quoted.

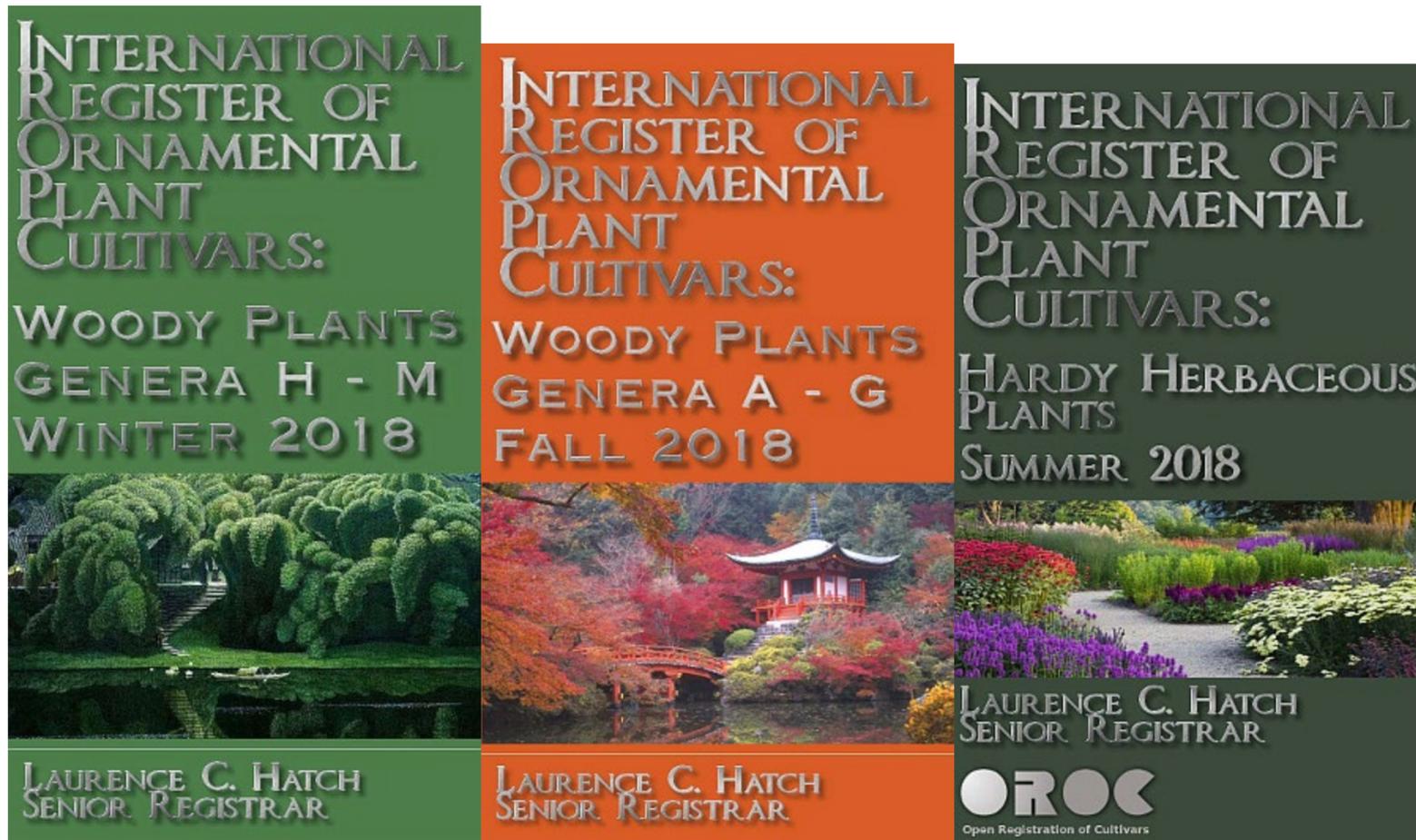
For a bit of nostalgia here's a snip of the New Plant Page (1993-2009) which was the web's first discussion of new ornamental cultivars with active source links to buy or study them. The Cultivar.org encyclopedias as well as thousands of other websites cover this now include the amazing **RHS Plant Finder**.

Agapanthus 'Elaine' - [source \(Monterey Bay Nursery\)](#)
Agapanthus 'Golden Rule' - [source \(Fir Tree Farm\)](#)
Agapanthus 'Mood Indigo' - [source \(Monterey Bay Nursery\)](#)
Agapanthus praecox ssp. praecox 'Getty White' - [source \(San Marcos Growers\)](#)
Agapanthus 'Purple Cloud' - [source \(Plant Delights Nursery\)](#)
Agapanthus 'Rancho White' - [source \(San Marcos Growers\)](#)
Agapanthus 'Snow Drops' - [source \(Terra Nova\)](#)
Agapanthus 'Storm Cloud' - [source \(Monterey Bay Nursery\)](#)
Agapanthus 'Streamline' - [source \(Terra Nova\)](#)
Agapanthus 'Streamline' - [source \(Plant Delights Nursery\)](#)
Agapanthus 'Tinker Bell' - [source \(Monterey Bay Nursery\)](#)
Agastache 'Blue Fortune' - [source \(Plant Delights Nursery\)](#)
Aglaonema - newer cultivars - [descriptions, sources \(AGLAONEMA.COM\)](#)
Aglaonema 'Pattaya Beauty' - [photo, wholesale source \(Plantara\)](#)
Agrostemma 'Ocean Pearl' - [source \(Thompson and Morgan\)](#)

Ajuga - NOS Database, Study Group - 
Ajuga 'Arctic Fox' (*V) - [Photo, source \(Klehm\)](#)
Ajuga 'Braunherz' - [source \(Roslyn Nursery\)](#)
Ajuga 'Pats Selection' - [source \(Heritage\)](#)
Ajuga 'Purple Torch' - [source \(Oasis Plants\)\(NZ\)](#)
Ajuga pyramidalis 'Leprechan' - [source \(Roslyn Nursery\)](#)
Ajuga reptans 'Kurt's Compact' - [source \(Cotswold Garden Glowers\)](#)
Ajuga reptans 'Mahogany' - [source \(Proven Winners\)](#)
Ajuga reptans 'Marble Glow' (*V) - [source \(Roslyn Nursery\)](#)
Ajuga reptans 'Renick' - [source \(Roslyn Nursery\)](#)
Ajuga reptans 'Ruffled Lace' - [source \(Roslyn Nursery\)](#)
Ajuga reptans 'Simon's Type' - [wholesale source \(Firma C. Esveld\)](#)
Ajuga 'Ruffled Lace' - [source \(Lost Horizons\)](#)
Akebia quinata 'Brookside Variegata' (*V) - [source \(Glasshouse Works\)](#)
Albizia julibrissin 'Umbrella' - [source \(Sollva\)](#)
Alcea rosea 'Peaches 'n' Dreams' - Spring 1999 - [source \(Wayside Gardens\)](#)
Alcea rosea 'Peaches 'n' Dreams' - [source, photo \(Thompson and Morgan\)](#)
Alchemilla mollis 'Thriller' - [photo \(Penn State Hort. Trial Garden\)](#)
Allium - newer, rare cultivars - [source \(Cotswold Garden Glowers\)](#)
Allium - new cultivars, species profiles - [view document \(BULB.COM\)](#)
Allium 'His Excellency' - Search for genus -> [photo \(Flowerweb\)](#)
Allium 'Mars' (A. stipitatum x A. aflatumense) - [source \(McClure & Zimmerman\)](#)
Allium 'Mars' (A. stipitatum x A. aflatumense) - [source \(McClure & Zimmerman\)](#)
<http://www.plantdel.com/> [scribed](#) - [view document](#)

OROC+NOW

For you early adopters of the newest cultivars, OROC (Open Registration Of Cultivars), which is 100% free via annual Registers, we created the **OROC+NOW** reference. It provides the very latest, pre-registered cultivars in woody plant genera exclusively to our subscribed of Cultivars of Woody Plants as a thank you for supporting that work and OROC registration projects. These will eventually come out free in the annual register(s) but advanced access is something we like to do in appreciation for funding this important, international cultivar work.



The OROC **International Register of Ornamental Plant Cultivars** volumes are always free to download from Cultivar.org. We now have over 98,000 combined views on Amazon, Google, as well as downloads from various pages, proving this kind of data is much in demand worldwide from more than 110 different countries. There is no telling how many copies were legally shared (we encourage it) as well as data extracted from the free **OROC Data Sharing** program (also encouraged) where authors can repurpose the cultivar names, descriptions, and links.

By the way the RHS Plant Finder has an older, wiser, more informed brother called the [RHS Horticultural Database](#) and any horticultural taxonomist of any specialization would be a fool not to check their work against this massive, useful system. Heck, it might inspire your own new work or a specialized plant collection or set of cultivar evaluations. It has that effect on folks.

It behooves me to put in a strong word for **Master's Theses and Doctoral Dissertations** as nomenclatural standards, especially not all get into academic, peer-reviewed literature in sufficient detail and thoroughness. Lots of the old stuff is not digitized and never sees the light of day. My own study of *Juniperus horizontalis* was 365 pages and it barely got to be 10 pages in literature and our hopes for a university-published bulletin (even with us claiming somewhat dubiously "every North Carolina nursery will want one") never came to be. Two of my favorites for their complexity, original research, brilliant analysis, keys, value in my studies, and more are:

- http://digitalcommons.lsu.edu/cgi/viewcontent.cgi?article=5001&context=gradschool_dissertations (**Liriope - Broussard**)
- http://udspace.udel.edu/bitstream/handle/19716/12870/Matthew_Lobdell_thesis.pdf?sequence=1 (**Styrax - Lobdell**)(Best species key?)

One day while searching around the Bailey Hortorium at Cornell as student doing summer janitorial work so I could get a free room and do research in the great libraries in my spare time, I came upon a huge Ph.D. work on garden junipers by a man named **John Farnsworth Cornman**. He later became a Professor of Turfgrass at the famed Agro-Ivy League University. He had all the resources of the massive university, the extensive and old plant collections, massive catalog collections, and vast herbaria. He ended up publishing lots of cultivar names he found and in my juniper volumes I

cite him very often. This work is still virtually unknown and I had the honor of sharing a bunch of photocopies with the great **Humphrey Welch** (The Conifer Manual, Dwarf Conifers) who found the studies remarkable and once again...unknown. I have copies of most of the pages and of course the Cornell Libraries do too. Had his work being known, our conifer literature would be very different. Another Cornell Dissertation is somewhat known in the herb community is the amazing study with new nomenclature by **Dr. Harriet Flannery Phillips** on the garden *Thymus*. My faculty advisor Dr. Robert Mower direct her in this work and pointed it out to me a nice model of morphometrics and new techniques. We got Margaret Easter, the world's leading authority on garden thymes today, author of **The Big Thyme Book**, and RHS ICRA for the genus, involved with her work and vouchers, bring people across the pond in unity to study this difficult taxonomy.

The **documentation of newly introduced cultivars** is as complex as we want to make it. Aside from the requirements of the ICRA for formal cultivar registration (sometimes meaning surrender of your own germplasm and image copyrights), it is good to 1) deposit an herbarium voucher at a local university, 2) distribute your plants to stable collections like to survive over time, 3) mark and label the location of stock in your own garden or nurseery (yes, people suddenly die and leave lots of this ambiguous and muddled, some named clones lost forever), 4) describe the plant fully with aid of a trained taxonomist if required, 5) make and keep as many high-resolution digital images and scans (hopefully with a ruler for scale and color chip) as possible, sharing them widely, 6) publishing it in a widely received publication (both popular and academic) or one likely to be archived in libraries, and 7) creating a website or page devoted to the new cultivar. In the following example, this new cultivar was not only photographed in detail but the image annotated with it's distinct features for future researchers to consider.

Hedera helix LUMINOUS LIME™

Bright chartreuse
to lime green

Showy
reddish
stems

Narrow
elliptic-
ovate
leaves
indoors

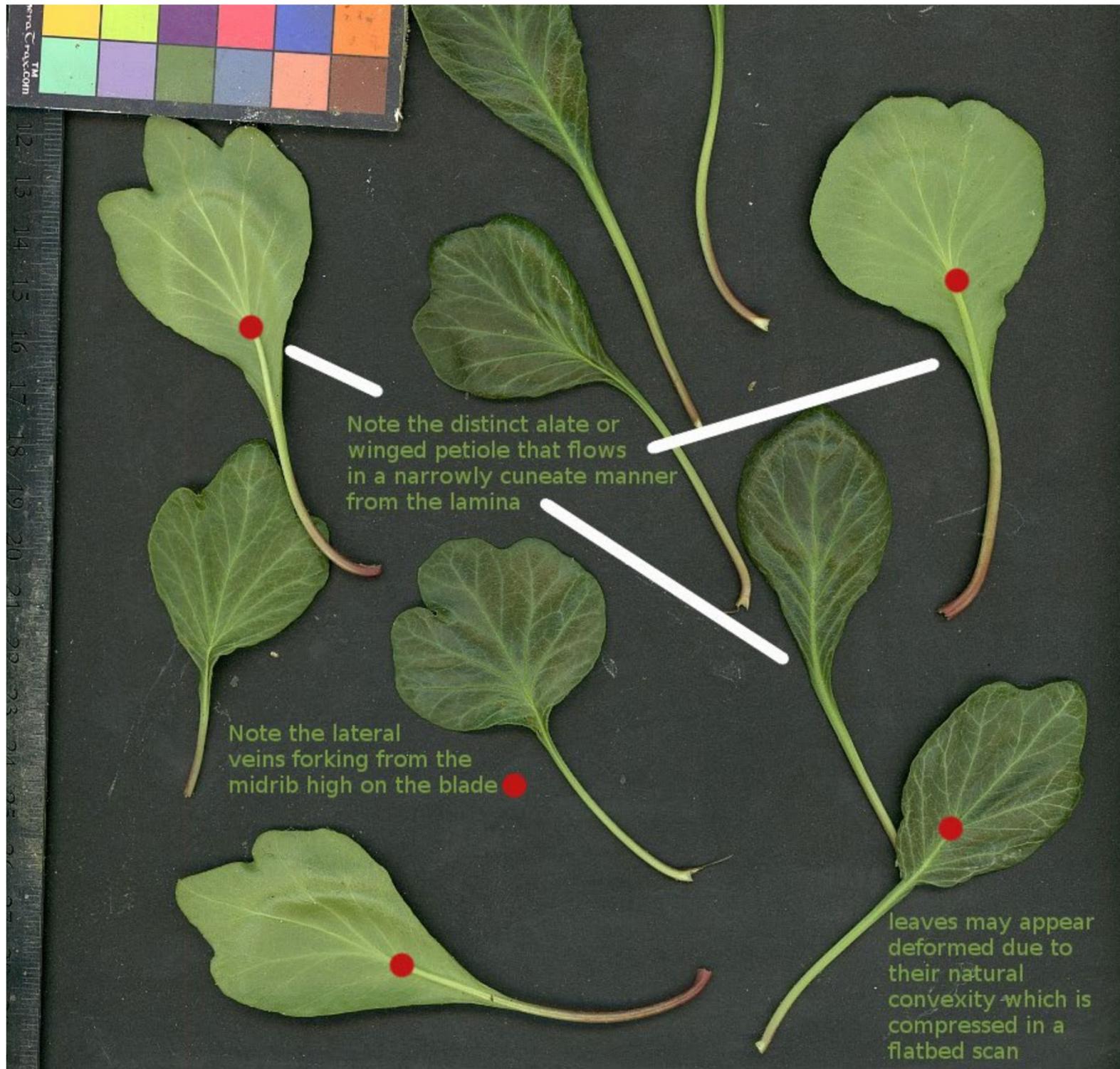
Cordiform
to
shallowly
3-lobed
outdoors

2012
NEW
ORNAMENTALS
SOCIETY
INTRODUCTION

Semi-dwarf,
non-invasive,
and
eco-friendly

Hedera helix [Green Ripple Group] 'Cary Green'





CHAPTER EIGHTEEN

THE IMPORTANCE OF PLANT RECORDS AND PROVENANCE IN TAXONOMY

A plant you don't have to identify or worry about its history is often a reliable nomenclatural standard for study, re-cloning or reintroduction. I learned this when visiting the Morton Arboretum in and obtaining a copy of the huge binder that Floyd Swink kept on all the collections with great detail on the **germplasm chain of custody** of propagated material. A typical accession would come from their own plant traceable yet again to an Arnold Arboretum plant which in turn could be traced to the originating nursery in Europe or the discoverer in the U.S. You had dates and accession numbers all the way down the line. Even today when I explore their BOL files (<http://bol.mortonarb.org/>) they list much of their older material with direct, proven connections to D.Hill, Hesse, Kelsey, Spaeth, Sieberthaler, Sakata, Meehan, Fairview, Cole, and other seminal nurseries.

The term **recloning** is sometimes used when a cultivar has gone from one original clone (**original intent**) to a seed strain or undetermined mix of clones, a basic germplasm corruption over time, usually the later two much more variable, and it is reclaimed or reset back to the original monoclonal status based on verified, original, or likely true material. Nomenclature convention prohibits named like *Plantus vulgaris 'Albus Nanus True'* which you seen in catalogs from time to time. I can go to Durand-Eastman Park in Rochester, New York and find the original or original-derived trees from Bernard Slavin and others who worked at the Rochester Parks, *Acer platanoides 'Erectum'* and *Pinus strobus 'Contorta'* (needles are NOT twisted) among a dozen others. They still exist today. If I want to be sure I really have *Picea likiangensis var. montigera* where better than to go the Arnold Arboretum and get permission to collect their 04-02-1992 which came from their stock of E.H. Wilson #4084 originally collected in Taichien-lu, W. Sichuan, China. Anything traceable to a Wilson introduction will have solid identification and provenance behind it. This also applies to the many cultivars that "The Arnold" has selected and named over the decades.

While on the topic of recloning, that is, returning a corrupted monoclonal original cultivar back into the real range of variation, let's talk a second of **seed strain cloning**, something that has created cultivars for centuries. Whether the seed strain is just a population of wild collected seed or a highly bred up set of nursery plants of elite potential, one can fix or freeze specific traits from a single plant as clone. Here is a hypothetical yellow-rayed daisy species and how you can pull out a dwarf cream-flowered variant as well as a golden, darker, larger clone. Many perennials as well as woody cultivars come from a seed lot of some importance or interest and a good clone or two is fixed or locked into a less variable set of phenotypes by vegetative propagation. Then the clone can be bred or raised from seed again, F1, F2, etc. and these results cloned for even better refinement of the group.

Plantus aureus f. aureus						
RAY COLORS						Seed strain
HEAD WIDTH		4.5 - 6.5 cm				Golden Queen
HEIGHT		42-61 cm				seedlings
		CLONING A STRAIN				
RAY COLOR						Clone
HEAD WIDTH		5.8-6.0 cm				Cream Dwarf
HEIGHT		42-43 cm				
RAY COLOR						Clone
HEAD WIDTH		6.0-6.5 cm				Golden Giant
HEIGHT		57-61 cm				

The term **provenance** used here is more about the chain of custody for the germplasm and not the use of the term in forestry such as "*Picea abies* from Mt. Nuba, 12455 ft. evaluation, near Nuba, Norway, native stand". They are related and if you are working with wild material both the chain of custody and wild provenance are helpful.

Provenance is also different from **pedigree**. The pedigree of a cultivar just like your prized poodle or Siamese cat is the product of breeding Mother E and Father F, which in turn sprang from A, B, C, and D are the grandparents. Humans tend to call our pedigrees our family trees or genealogy.

Pedigree verification is one reason we use cultivar fingerprinting today but it's always best to have controlled (pollen excluding) breeding and very detailed, accurate breeding records.

The purpose of infraspecific taxonomy in the earliest of human times was a purely economic one, a farmer in particular needing to know he had the best variety of plant in his field or finest, most productive animal in his barn. Provenance, pedigree, and performance of the strain, breed, or cultivar was all important. His neighbor and competitor paid the same or a little more for his corn and beans but got twice as many ears per acre and a more flavorful, tender pod of beans. He however had a better line of cattle so the milk cows produced more milk with higher milk fat content and less mortality. These infraspecific taxa, whatever type of rank you assign them, are still household names like Russet, Hereford, Rhode Island Red, Burbank, Pippin, Cabernet, Holstein, Bing, Beefsteak, Yorkshire, Kobe, Savoy, Saaz, and Elberta among economically important plants. Ornamental plant taxonomy at the infraspecific level is also an economic matter as we spend billions a year on our landscapes and gardens. Plant the wrong cultivar of shade tree and you could someday be out thousands of dollars in arboricultural fees if not damaged property with out-of-pocket deductibles. I recently saw a massive shopping mall planted with about 400 junipers that succumbed to blight; brown, dying, ugly as sin. They had to be removed and replaced at enormous expense, the huge landscape crew being paid for about two weeks of work.

I place a very high value on **Originator Derived Germplasm (ODG)** where the clonal material (unless a seed strain from the beginning) is traceable with no ambiguity to the originating nursery, person, garden, or institution by historical evidence, preferably accession or collection numbers, dates, and certification documents. I will accept the cultivar registrant or nominant if need be as they should have the real thing too.

This hypothetical example of *Plantus speciosus* '*Glaucus Smithii*' would be my ideal sort of provenance for clonal, cultigenic cultivar material:

- 1. Joe B. Smith Nursery - 1904 (originator) - listed in Catalog 1903-04: 23, with color image, grafted
 - 2. Metropolis Arboretum #04-012, Plantus Collection, received on 3 March, 1904 from 1.
 - 3. Metropolis Arboretum #18-089, New Plantus Bed PL04W, propagated by cuttings on 9 November 1918 from 2. Joe B. Smith, originator verified ID on his visit on 7 July 1926 as true
 - 4. Gotham Botanical Garden #034532, South 45-F propagated by grafting on 17 October 1932 from 3.
 - 5. My Arboretum #61-934, Plantus Bed #32-6 propagated by grafting on 19 November 1961 from 4.

Now let's look at two other ways of getting '*Glaucus Smithii*' into My Arboretum, one in **blue**, one in **green**:

- 1. Joe B. Smith Nursery - 1904 (originator) - listed in Catalog 1903-04: 23, with color image, grafted
 - **9. Rural Arboretum #09904, Bed 55T-C and Bed 55T-D, ordered from 1. catalog in 1904, five plants**
 - **10. Jones Nursery as 'Smithii', 1961-63 Spring Catalog, presumed to be grafts made from 9. from scions collected about 1957-1959 during visit there, foliage more juvenile, divergent than typical**
 - **11. My Arboretum #62-113, West Bed W29, as unrooted cuttings, on 9 July 1962 from 10.**
 - 2. Metropolis Arboretum #04-012, Plantus Collection, received on 3 March, 1904 from 1.
 - 3. Metropolis Arboretum #18-089, New Plantus Bed PL04W, propagated by cuttings on 9 November 1918 from 2. Joe B. Smith, originator verified ID on his visit on 7 July 1926 as true
 - **6. ?Slack Arboretum as rooted cuttings from Metropolis Arboretum, thought to be around 1932, possibly from 3. but no accession**

number recorded

- 7. Job's Nursery, obtained cuttings from Slack Arboretum, July 1956 from 6.
 - 8. My Arboretum #62-112, West Bed W22 as rooted cuttings from 7.
- 4. Gotham Botanical Garden #034532, South 45-F propagated by grafting on 17 October 1932 from 3.
 - 5. My Arboretum #61-934, Plantus Bed #32-6 propagated by grafting on 19 November 1961 from 4.

So what's not good or less than best about the green accession pathway? First of all, they sourced five plants (9.) in two different beds from originator under one accession number. They were grafted so that might be okay. Still gives you some pause. In 10. Jones Nursery changed the name a little and we don't know which of the five original plants they sampled, especially as the result it is said to be more juvenile, divergent of leaf than normal. Did one plant revert or change or was it sampled from atypical tissue at the base? The date of the visit to Rural Arboretum is unclear also. The blue pathway is full of questions because Slack Arb (6.) got their plants from Metropolis but the year and accession number are unclear. They might have even sampled their older 1904 plant if it was still alive. Then Job's Nursery got cuttings and they had no accession number either from Metropolis or Slack. In short, the accession #61-934 has the best, most traceable and clear provenance from the originator.

The **collectors number** is valuable for documentation though it is not the same accessioning individual plants at the specific garden or site. Crug Farm and Plant Delights Nursery are two examples of nurseries that do a very fine job presenting their collection numbers or those of other parties in their catalogs. In the case of both of these firms, they often have named and unnamed clones from the same species but each collection number with a different but useful phenotype. Sometimes there is a nice nexus between collector's numbers and herbarium vouchers if the collector records his or her own material on the label. In fact, some of the better online herbaria allow a search by this number.

Today we often have plant collection accessions data linked to mapping and GPS displays. These help us find good nomenclatural standards especially among endangered and rare cultivars. Cultivar.org has organized some of the best of these at our **Virt-Arb™** or [Virtual Arboretum](#) page. I have found many old cultivars I thought be lost or severely endangered in these resources. This kind of systems also work on your tablet or phone and make exploring a plant collection while there much easier. Have I seen all the Cercis cultivars before leaving? Is that bit of the collection worth driving over to exploring? Is that planting I saw 20 years ago still full of good, rare stuff? I just remember this great tree of X, is it still around? I once spent four days going fence to fence the U.S. National Arboretum to photographically ransack all the spread out collections. If I had their mapping tool today my interest might have been solved in a day or two less. And by the way, always plan your trip to a botanic garden or arboretum using **Google Maps** and scan the entire place. You may find some things not officially on the map but perhaps accessible to researchers if you ask the right people. I have and those hidden, fenced off areas for evaluation, nursery production, and research are sometimes priceless. Those private tours from directors, researchers, and curators are some that still fill my mind and image library. "The director would like to meet you" is a good sign when you come to any garden and explain your goals. It is of course best to write ahead so the experts are free and waiting for those tours.

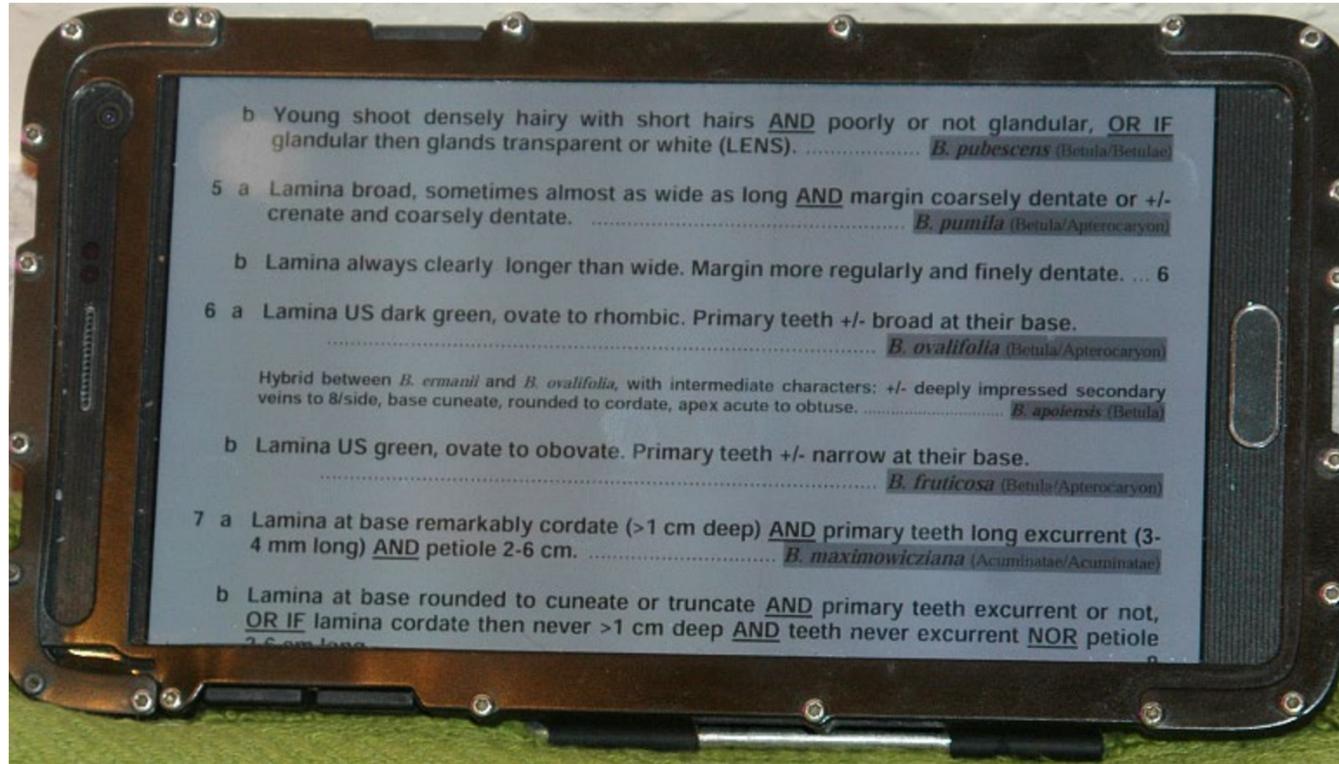
CHAPTER NINETEEN\

GREAT AND PRACTICAL KEYS TO GARDEN TAXA

The **Encyclopedia of Herbs** (2009) by Tucker and DeBaggio is a must for any library. Tucker is a taxonomist and DeBaggio a famous nurseryman and together their combined expertise is remarkable. The cultivar-level keys and very detailed descriptions of cultivars is stunning. This volume is way

more taxonomic and precise than the name implies. If you work with any plant that has nice scent, you need this book.

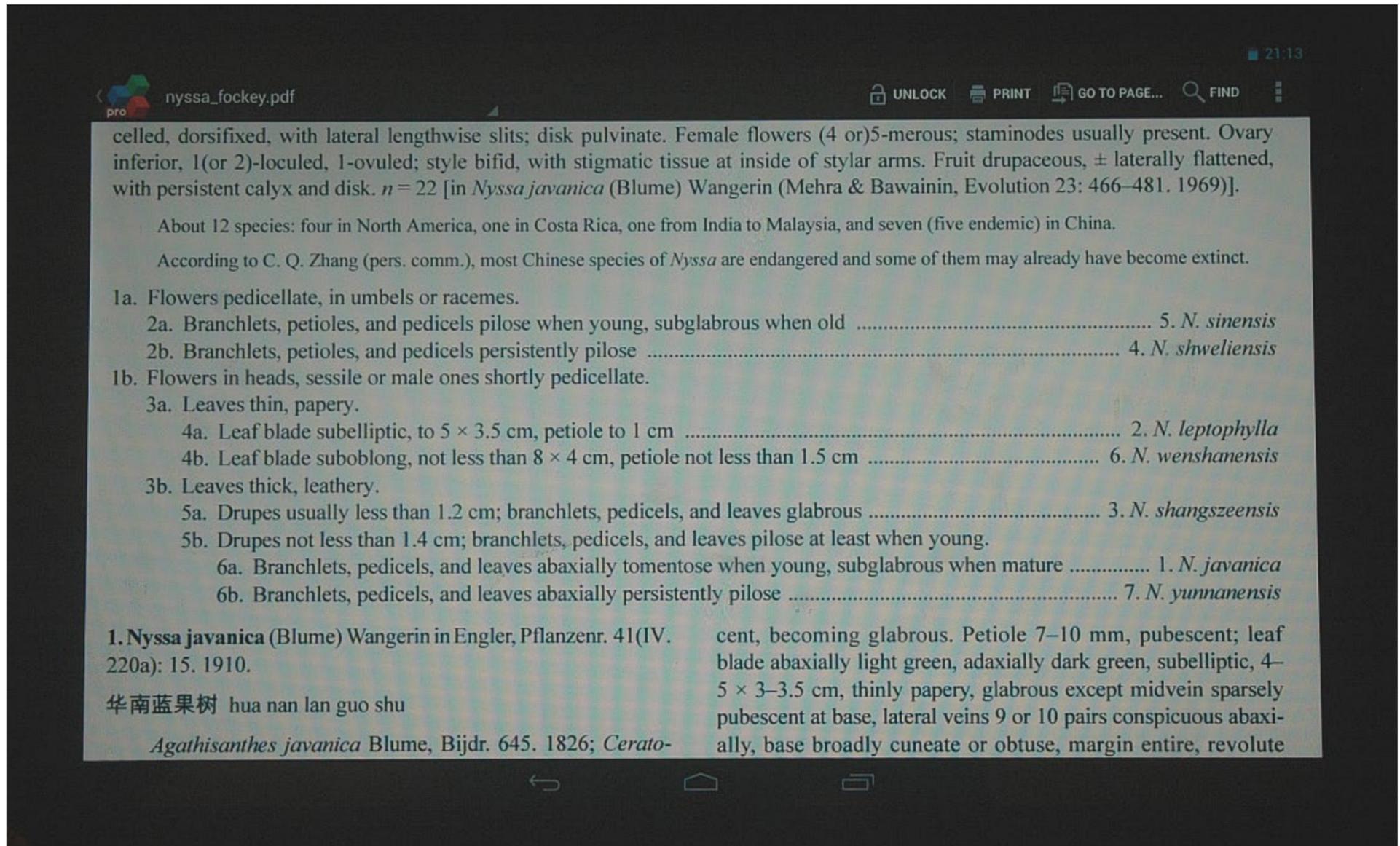
I mentioned the **European Garden Flora** before and to me it's the finest for herbaceous perennials and sometimes conifers, written by many of the European authorities on each genus.



A portion of a **Betula key from Jan de Langhe**, easily visible as PDF download on any phone or tablet for field work.

By far the best, most accurate, modern, original, taxa-dense, and horticulturally practical keys to woody plants are those by **Dr. Jan De Langhe**. I download every single PDF key to my devices and keep a set on my smart phone for field work. He also has plant leaf scans to support this work if you are curious about the material he used in the work. Are you lamenting that Rehder's Manual or whatever is not revised? Give no worry and go here:

https://www.arboretumwespelaar.be/EN/Identification_keys_and_illustrations/Identification_keys/



The **Flora of China** is going to be important to any ornamentals taxonomist and are the general works at www.efloras.org. I carry this *Nyssa* key on my phone because I'm a nerd I guess. The same is true of the **Flora of North America**.

Folks in the forestry community dealing with clonal stock work at the cultivar level too and encounter similar problems as ornamental taxonomist. Here's an interesting project to **key out poplar cultivars** with some images to assist. Go to the end of the paper for the key portion.

http://foris.fao.org/static/pdf/ipc/VOLUME_PRIMO_chiave.pdf

All of us keying out native ornamental plant benefit highly from a **local flora with good, original keys** that have been tested and most importantly by specific experts in each genus. If you work with southern and mid-atlantic states plants in the US you will find **Weakley's Flora** (PDF) and the **Floraquest** app very useful. I would not begin to key out on the southern *Quercus*, *Salix*, *Ilex*, *Heuchera*, and dozens of other troubled, confusing genera without a PDF of Weakley on my phone and tablet (both). Taxonomic concepts have changed in the last few decades and this is one flora which has made those nomenclatural and descriptive changes down the infraspecific level with ease and class.

<http://www.herbarium.unc.edu/flora.htm>

Because we must understand the related botanical taxa before understanding cultivars, where they fit, where they came from, and where they belong, good botanical delimitations are necessary. I found it necessary write my own charts and keys for **Cultivars of Woody Plants** before I could get a grip or grasp or hold on the garden material. This chart of *Acer ginnala* and *A. tataricum* was essential to sorting the rest of our garden material

out. I compiled it from many sources and these are regularly updated. As with all the Cultivar.org databases, these ID charts are in PDF form and portable on any phone, tablet, or laptop.

CHARACTER	Acer ginnala subsp. ginnala	Acer tataricum subsp. aidzuense	Acer tataricum subsp. tataricum	Acer tataricum subsp. semenovii	Acer ginnala subsp. theiferum
Habit/Form	large shrub to medium tree, 6-15m, by far the largest subsp. in this chart.	smaller than subsp. ginnala on average but also capable of 6-8m with time.	large shrub to small tree, 5-10m tall	shrub to small tree, 3-5m tall, very often wider than tall and more spreading than other subsp. here	unreported
Leaf thickness	thinner, papery	--	thick, leathery to subcoriaceous	thick, leathery to subcoriaceous	thinner, papery
Leaf dimensions	6-10cm long x 4-6cm wide	smaller than subsp. ginnala on average	5-8cm long x 3-4cm wide	1.2-2.5cm long x 1.0-3.2cm wide - a very small blade in some examples. It could reach 3.5cm long but never the 8-10cm length of subsp. ginnala.	5.0-8.0cm long x 2.5-5.0cm wide
Leaf margins	more singly serrate on average than subsp. tataricum, some double-teeth occur	--	more often doubly serrate than subsp. ginnala	single to doubly serrate	usually double-serrate
Leaf base	subcordate to truncate	--	rotund to subcordate	rotund (rounded)	--
Leaf, fruit, and flower	Leaf below becomes very glabrous with	(unknown)	distinctly glandular flowers, leaves persistantly	leaf glabrous at maturity but flower very glandular. Fruit is	leaf white pilose below when young,

vestiture	maturity. Fruit is glabrous at maturity.		pubescent on veins below with maturity	pubescent-glandular at maturity.	flowers also white pubescent
Leaf lobing	deeply to shallow 3-5-lobed, often nicely incised in cultivars. It is very rarely unlobed on old trees as with subsp. tataricum	very variable on one tree, unlobed to distinctly 3-lobed. Some leaves have numerous secondary lobes on the primary ones. There is room for leaf shape selection in this subsp.	young shoots ONLY are 3-5 lobed but distinctly unlobed on mature plants with less vigorous shoots. The numerous unlobed leaves on older plants make for a very clear separation from old trees of subsp. ginnala.	variable, unlobed to distinctly 3-lobed on strong young examples. Some young plants are very deeply cut and resemble a birdsfoot <i>Hedera</i> cultivar. The basal lobes are often more divergent (veins at right angles) compared to subsp. ginnala.	often unlobed, shallowly 3-5 lobed at times
Fall leaf color	often glowing, bright red to scarlet shades	pale, not usually bright red nor showy	little or none, leaves often dropping earlier than subsp. ginnala. Some garden clones have a slight yellowish, pleasing color.	not often bright or showy	not reported.
Samara length (including seed or nut)	2.5-3.0cm - shorter than subsp. seminovii	--	2.5-3.0cm long	3.0-3.5cm long	2.5-3.5cm long
Samara angle in schizocarp	--	--	wings often parallel	more divergent or parallel than subsp. ginnala	wings at a much narrower, acute, even

					right angle
Inflorescence	variable, often abundant but frequently hidden in foliage, yellowish-white	loose, open panicle not so full and dense as subsp. tataricum	erect, dense, cream to white panicle, often a very showy flower compared to others in this group.	showy flowers not reported	--
Petal color	white to greenish-white	--	greenish-white	greenish - not so white as subsp. ginnala	--
Geography	NE China, Manchuria, Japan, North Korea	Honshu, Shikoku, Kyushu, Hokkaido	E Europe, Austria, Hungary, Serbia, Turkey, Romania, Ukraine	SW Asia, S Ryssia, Turkistan, China, Afghanistan	China, limited distribution

Based on species and variety concepts in Adam's key in Junipers of the World, the more common garden variants of this species and relatives can be grouped as follows in this key written for Cultivar of Woody Plants. His solid concepts and measurements along with my own got us to this place, a useful key I think, even if trichotomous in spots.

1. Plants mounded, procumbent to low-decumbent.....2
1. Plants arching-spreading to tall-decumbent.....3
1. Plants upright-ovoid to near columnar.....4

2. Plants dense, compact mounds; leaves 5-7mm long, intense steel blue to dark glaucous blue, old plants never with adult, scaly needles.....J. squamata var. squamata Meyer Group 'Blue Star'
2. Plants low procumbent, usually a groundcover; leaves 3-5mm long, bluish-green, older plants often with some adult, scaly needles.....Juniperus pingii var. wilsonii Prostrata Group

3. Needles 6-7mm long; female strobili 8-9mm wide.....J. squamata var. squamata and cultivars
3. Needles 3-5mm long; female strobili 4-5mm wide.....J. squamata var. squamata var. wilsonii and cultivars
3. Needles 4-10mm long; female strobili 5mm wide.....J. squamata var. fargesii

4. Plants upright-arching, 2-3x tall as wide, flame-like to subtortulose; leaves intense glaucous blue.....J. squamata var. squamata Meyer Group
4. Plants shrubby, subglobose, 1-2x tall as wide, spreading to irregular, not tortulose; leaves green to bluish-green.....J. squamata var. squamata

CHAPTER TWENTY

THE ROLE OF DESCRIPTORS IN CULTIVAR REGISTRATION AND GERMPLASM MANAGEMENT

A **descriptor** is a category of data, trait, or character used to describe an organism or object. The **descriptor value** is the term, number, or text assigned to each descriptor. Corolla flower color and maximum leaf length are descriptors or categories of plant data. Their descriptor values could be pink, white, yellow and 12cm, 36cm, or 6 inches, respectively. One is a data field and the other the data that goes into it. They are similar to objects in the computer programming world. Traditionally, descriptors and their values are also called **characters** and **character states** as well as **traits** and **trait values**.

In the cataloging of plant, microbial, and animal germplasm, **specific descriptors are used for specific species** or groups of germplasm. This allows the germplasm experts to but in specific descriptors valued for each taxon as well as reducing the number of redundant ones. If you had a database of all plants, you will need more descriptors than for a single species' cultivars which all imply the species traits in common (leaf arrangement, ovary position, fruit type).

The United States Department of Agriculture in their **GRIN** germplasm system has standardized descriptors for scores of different species as do most programs around the world. There is a general GRIN set for woody plants sampled below. Note that the descriptors are grouped into chemical, morphological, comment (ie. ploidy), other (usually images), phenology, and stress tolerances. Most databases also have historical fields that record the originator, their organization, literature references, dates, times, places, methods of origin, and so on. You also have to record the accession number of the object, it's form (seed, living plant, cryopreserved tissues, TC sample, pollen, etc.), it's location, and any restrictions on it's use.

Choose Crop: **WOODY-LANDSCAPE** (Click this link to go to crop page)

WOODY-LANDSCAPE ▼ **New Search**

Choose descriptor(s): **Clear Descriptor Choices**

Chemical composition descriptors (CHEMICAL)

Choose All Chemical Descriptors **Clear All Chemical Descriptors**

- BRIX OIL OLEIC PALMITIC STEARIC
 LINOLEIC

General information (COMMENT)

Choose All Comment Descriptors **Clear All Comment Descriptors**

- ECOREGION PLOIDY

Morphological descriptors (MORPHOLOGY)

Choose All Morphology Descriptors **Clear All Morphology Descriptors**

- CATKIN WIDTH FRUITDIAM NUTLENGTH PERICARPLGTHS PLTWIDTH10
 CATKINLGTHS FRUITWT NUTLETLGTHS PERICARPWDTHS SEEDDIAM
 FLOWERCOL INFLCOUNT NUTLETWDTHS PLANTSHAPE SEEDLGTHS
 FLOWERDIAM INFLLENGTH NUTTHICK PLTHGT SEEDWDTHS
 FLOWERPROF INFLWIDTH NUTWIDTH PLTHGT10 SEX
 FRUIT DIAMETER LAI PEDUNCLE LENGTH PLTWIDTH

Uncategorized descriptors (OTHER)

Choose All Other Descriptors **Clear All Other Descriptors**

- IMAGE_01 IMAGE_03 IMAGE_05 IMAGE_07 IMAGE_09
 IMAGE_02 IMAGE_04 IMAGE_06 IMAGE_08 IMAGE_10

Phenological descriptors (PHENOLOGY)

Choose All Phenology Descriptors **Clear All Phenology Descriptors**

- FIRSTFLOW PEAKFALL PEAKFLOW PEAKRIPE

Environmental stress descriptors (STRESS)

Choose All Stress Descriptors **Clear All Stress Descriptors**

- HLTHCNTRL HLTHFLOOD LEAFAFLOOD PNFLOOD TEFLOOD
 HLTHDRGHT LEAFADRGHT PNDRGHT TEDRGHT USDACOLD

Descriptor: Leaf Pubescence (LEAFPUB)[Download list of accessions evaluated for this trait](#)

Definition:	Leaf pubescence (upper surface)
Crop:	ECHINACEA
Category:	Morphological descriptors
Status:	Crop Germplasm Committee approved
Data Type:	Alpha/numeric descriptor
Maximum Length:	1
Responsible site:	North Central Regional PI Station (NCZ)

Studies or environments for this trait

- [ECHINACEA.INC.AMES.2000](#) - (93 Accessions)
- [ECHINACEA.INC.AMES.2002](#) - (27 Accessions)
- [ECHINACEA.INC.AMES.2004](#) - (21 Accessions)

Distribution of Values for Leaf Pubescence (LEAFPUB)

Code	Definition	Number of Accessions
1	Smooth	20
2	Smooth with appressed hairs on margin	8
3	Soft	46
4	Rough	97

The GRIN descriptors for Echinacea above classify LEAFPUB (Leaf Pubescence) into four, perhaps really three groups and they know how many taxa of each they have such as 97 rough, 46 soft, and 28 more or less glabrous and smooth.

Descriptor: Leaf margin teeth (LEAFTEETH)[Download list of accessions eval](#)

Definition:	Leaf margin teeth
Crop:	MULBERRY
Category:	Morphological descriptors
Status:	
Data Type:	Alpha/numeric descriptor
Maximum Length:	20
Responsible site:	Natl. Germplasm Repository - Davis (DAV)

Studies or environments for this trait

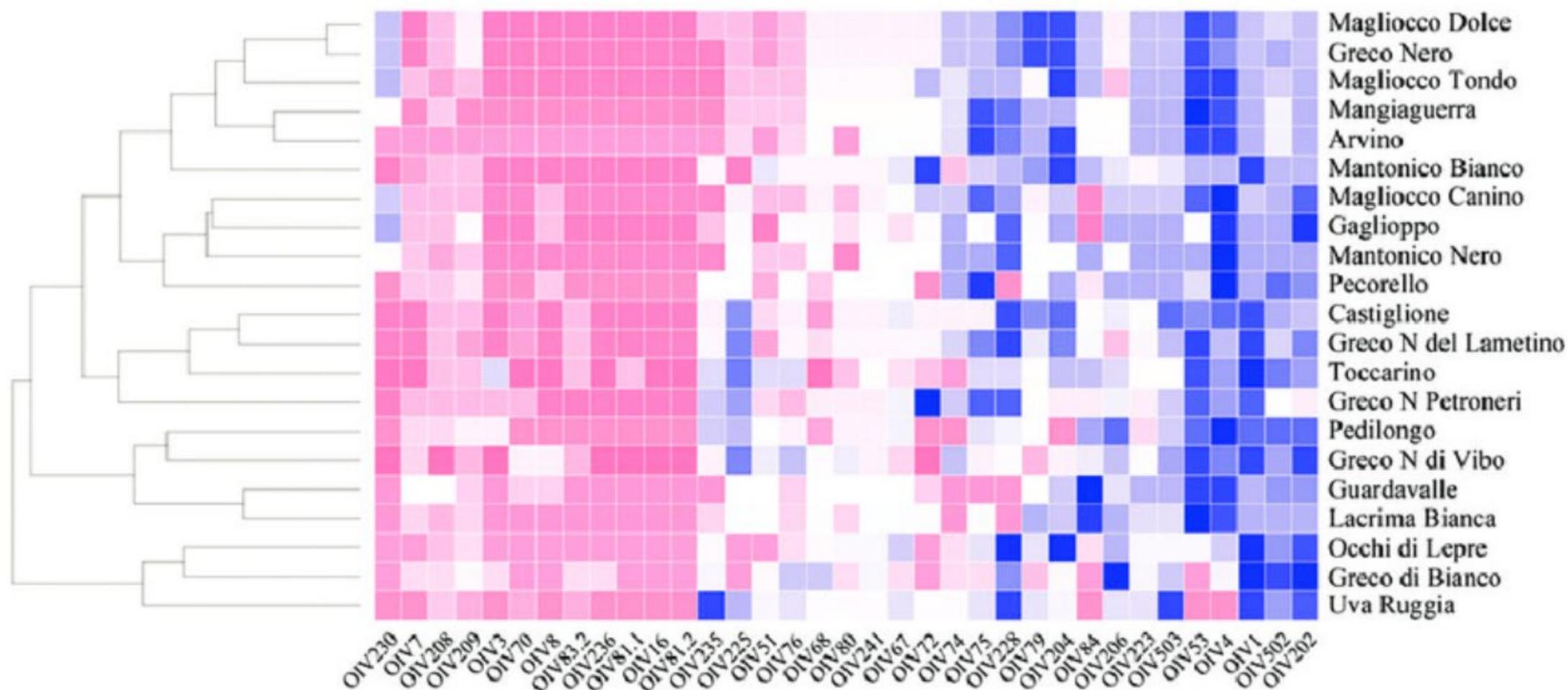
- [MULBERRY.CHAR.WEO.09](#) - (33 Accessions)

Distinct Values for Leaf margin teeth (LEAFTEETH)

Value	Number of Accessions
Acute-serrate	19
Double serrate	4
Mastoid-serrate	37

More mulberries (generally non-ornamental) in the genus Morus, 19 have acute-serrate leaves, 4 double serrate, and 37 mastoid-serrate. How is that for morphological precision?

The most advanced descriptor programs and databases for cultivar-level work seems to be among grape or *Vitis* growers. We in the ornamentals community can learn an immense amount from them. There were originally 29 descriptors for *Vitis* cultivars but the maximum set is 128 though their codes have higher numbers as spaces were left for additions. Basheer-Salimia from Palestine created this beautiful cultivar chart that is both a dendrogram and a **heatmap** to the internationally standardized OIV descriptors.



Thirty-six Organisation Internationale de la Vigne et du Vin (OIV) descriptors recorded for the accessions belonging to the main grapevine cultivars from Calabria. Heatmap was used to describe the variation in the OIV descriptors. Different colours and gradients represent the categories for each descriptor reported in Table S2.

Basheer-Salimia, Rezq. (2015). Ampelographic characterization of white grapevine cultivars (*Vitis vinifera* L.) grown in Palestine. Palestine Technical Univ. Res. Journal. Volume 3.

Let's examine a few of the descriptors found on the left side of this chart.

oiv7= color of dorsal side shoot internodes

oiv230= color of berry flesh

oiv208= bunch shape

oiv209= bunch number of wings

oiv3= young shoot intensity of antocyanin on prostrate hairs at tip

OIV mature leaf traits and potential coded values are interesting and they are as follows. You can imagine how many hours it would take to

characterize just one cultivar for leaves let alone the full 128 descriptor set.

Mature leaf

Mature leaf: shape of blade

1=cordate

2=wedge-shaped

3=pentagonal

4=circular

5=kidney-shaped

Mature leafMature leaf: number of lobes1=entire

2=three

3=five

4=seven

5=more than seven

Mature leafMature leaf: anthocyanin coloration of the main veins on the upper side of the blade

1=absent

2=petiol point red

3=red until the first bifurcation

4=red until the 2nd bifurcation

5=red beyond the 2nd bifurcation

Mature leafMature leaf: goffering of blade1=absent or very weak

3=weak

5=medium

7=strong

9=very strong

Mature leafMature leaf: profile

1=flat

2=folded at mid vein

3=involute

4=revolute

5=rolled

Mature leafMature leaf: blistering of upper side

1=absent or very weak

3=weak

5=medium
7=strong
9=very strong

Mature leaf Mature leaf: shape of teeth

1=both sides concave
2=both sides rectilinear
3=mixture between notes 2 and 4
4=both sides convex
5=one side concave
one side convex

Mature leaf Mature leaf: degree of petiole sinus opening

1=very wide open
2=open
3=slightly open
4=slightly overlapping
5=overlapping
6=strongly overlapping

Mature leaf Mature leaf: shape of base of petiole sinus

1=U-shaped
2={-shaped
3=V-shaped

Mature leaf Mature leaf: presence of teeth in the petiole sinus

1=none
2=occurrence of 1 or 2 teeth in the petiole sinus

Mature leaf Mature leaf: petiole sinus limited by veins

1=none
2=occurrence on one side of petiole sinus
3=occurrence on both sides of petiole sinus

Mature leaf Mature leaf: presence of teeth at the base of upper leaf sinuses

1=none
2=frequently occurring

Mature leaf Mature leaf: density of prostrate hairs between the main veins (lower side)

1=none or very weak

3=weak

5=medium

7=dense

9=very dense

Mature leaf: density of erect hairs on the main veins (lower side)

1=none or very weak

3=weak

5=medium

7=dense

9=very dense

Can germplasm databases help us find new and promising ornamental plants? The answer is yes, absolutely yes. Here are two links about Musa and Ananas (pineapple) where it is discussed how to find ornamentals among the commercial, mainly pomological cultivar data. In pineapple we might be looking for red, purple, or variegated foliage, spineless blade, compactness, and small yet colorful fruit.

- https://www.researchgate.net/figure/Descriptive-statistics-for-15-descriptors-of-ornamental-banana-tree_tbl1_226312676
- <https://link.springer.com/article/10.1007/s10722-011-9763-9>

Specialized descriptors for atypical morphology is important in the broader scheme of things in ornamentals taxonomy. Just like the Veterinary surgeon who might asked to cut into anything than moves, the ornamental taxonomist needs to be fluent in the structure of many different genera (kinds of beasts and creatures) as well as breeds and species that differ very much them the common sorts. (And yes I as a taxonomist has saved the lives of a green creatures I could not yet name). Take the venus fly-trap of **Dionaea** and it's 100+ cultivars. They are separated by descriptors such as trap length, trap shape, trap color (including markings), petiole color, petiole length, trap tooth shape, tooth color, rosette shape, and leaf length among other metrics. The ornamental pitcher plants or **Sarracenia** are delimited from the other named clone by things like pitcher base color, upper pitcher color, aereole, pitcher width, pitcher height, flange color, flange margin, sinus netting pattern, outer hood color, inner hood color, pubescence, peristome, sepal shape, sepal color, and petal color. Cacti of many genera and species are measured for their tubercles, areoles, spines, glochids (color and length both), tepal shape, tepal color, pedicel color, and tepal count. Some of the highly specialized genera like **Epiphyllum** have a very unique set of traits are shown the Epiphyllum Society of America's Cultivar Registration Form:

http://www.epiphyllums.org/sites/default/files/ESA_Reg_Form_2017_o.pdf

Likewise the waterlilies of **Nymphaea** have some specific descriptors that need to be measured:

<https://iwgs.org/wp-content/uploads/IWGS-Nymphaea-Registration-Form-2019.pdf>

Ornamental plant germplasm in the US is found at many locations and can be requested through the GRIN network. Overall, the herbaceous ornamentals are maintained at the Ohio State University/USDA [OPGC \(Ornamentals Plant Germplasm Center\)](#) while woody plants of ornamental are located mostly at the U.S. National Arboretum and Beltsville Research Center with Dr. Kevin Conrad in charge of this broad, vast collection. Plant breeding and selection within the USDA, both for nursery stock and soil conservation occur at many stations so the genus and species of interest to you may should be researched within the [GRIN](#) and [USDA Agricultural Research Service](#) sites to find what researcher and location to contact and what projects already are in place. The OSU herbaceous location has "priority genera" which include Begonia, Coreopsis, Lilium, Phlox, Rudbeckia,

and Viola.

The germplasm resources outside the US for ornamentals are a bit harder to find on the internet. I did find a plan to conserve **Chrysanthemum cultivars** by the RHS and NCCPG at this page:

<https://www.nccpg.com/Conservation-resources/Growing-Heritage/HeritageActionPlanFinal.aspx>

Decisions have to be made on what germplasm is old and worthless, i.e. slated and fated for **de-accessioning** or physical removal, and what is heirloom stuff and may somehow, somehow contain rare genes needed in the future. We simply don't know so a full-blown resource will keep everything. In the real world, very few institutions can maintain "everything", especially when of doubtful origin. Cornell at Geneva keeps, I understand, something like 30,000 different accessions, a few thousand named cultivars, of *Malus x domestica* and related species of edible potential. These are apple trees and not some tiny petri dishes. Very few places can do that. Chicago B.G. did a fascinating study in some key genera of interest to northern collections, breeding programs, and evaluation projects with data gathered from several other institutions and leading references (cultivar.org included):

https://www.chicagobotanic.org/sites/default/files/pdf/plantcollections/shrub_cultivars/Cultivar_Preservation_Study_Summary.pdf

https://www.chicagobotanic.org/collections/curation/shrub_cultivars

Read both links if you will. Among other things they determined how many cultivars were represented by 2 or more sites, 1-2 sites, or likely none at all. The results are quite informative.

There are many private ornamentals **breeding projects** in the US from specific nurseries. Some of the public, university and taxpayer funded ones of some size and multi-generic scope include the following. These Ph.D. breeders, their graduate students, and staff are fundamentally good geneticists, cytologists, and ultimately taxonomists in most cases. Their papers cover a range of fields.

- Cornell University: <https://plbrgen.cals.cornell.edu/people/mark-bridgen/>
- Holland: <https://www.ornamentalbreeding.nl/>
- North Carolina State University: <https://mcilab.cals.ncsu.edu/>
- North Dakota State University: <https://www.ag.ndsu.edu/plantsciences/research/woody-plants>
- Oregon State University: <https://plantbreeding.oregonstate.edu/plantbreeding/research/ornamental-plant-breeding-program>
- Rutgers University: <https://breeding.rutgers.edu/holly/>, select also dogwood from menu
- University of Georgia: <https://site.caes.uga.edu/horticulture/category/ornamental-plant-breeding/>
- University of Wisconsin: <https://site.caes.uga.edu/horticulture/category/ornamental-plant-breeding/>

USDA Plant Inventory and Plant Introductions. Want or need to know every plant the USDA has imported from other places and even from US growers over the last century or so? I used to be frustrated because the Google Books inventory books were limited and many missing. This website has all of them I believe.

<https://www.ars.usda.gov/northeast-area/beltsville-md-barc/beltsville-agricultural-research-center/national-germplasm-resources-laboratory/docs/plant-inventory-books/>

And if you are a "plant nut" for rare ornamentals the USDA Plant Inventory or PI listings are very fascinating and contain some highly scarce and unique material. Take a look at these 1957 imports from Japan. I happened to be shown the original plant of *Zelkova serrata* 'Fuirikeaki' in Washington, the variegated clone often sold as 'Variegata' or 'Goshiki' today and have pictures of it in CWP. The tree was labeled 'Tukumo-keaki', the dwarf one, so must have gotten confused somewhere with the variegated intro. There's nothing dwarf about the full-sized tree. It was almost certainly this introduction. By the way, "keaki" is the common name for the genus so the cultivar should actually be 'Fuiri', meaning variegated or spotted.

236210 to 236254—Continued

- 236233.** ILEX CRENATA var. NUMMULARIA (Franch. & Sav.) Yatabe
Aquifoliaceae. **Holly.**
- 236234.** ILEX CRENATA Thunb. **Japanese holly.**
'Sirofokurin'.
- 236235 and 236236.** JUNIPERUS CHINENSIS L. Pinaceae. **Chinese juniper.**
236235. 'Ogon-ibuki'.
236236. 'Tama-ibuki'.
- 236237.** MAHONIA FORTUNEI (Lindl.) Fedde Berberidaceae.
- 236238 and 236239.** NANDINA DOMESTICA Thunb. Berberidaceae.
236238. 'Goshiki Nanten'.
236239. 'Sasaba Nanten'.
- 236240.** OSMANTHUS FRAGRANS Lour. Oleaceae.
- 236241.** OSMANTHUS HETEROPHYLLUS (G. Don) P. S. Green
'Ogon Hiragi'.
- 236242.** PACHYSANDRA TERMINALIS Sieb. & Zucc. Buxaceae.
'Variegata'.
- 236243.** TAXUS CUSPIDATA var. UMBRACULIFERA Makino Taxaceae.
- 236244 and 236245.** TERNSTROEMIA GYMNANTHERA (Wight & Arn.) Sprague
Theaceae.
236244. 'Hagikano'. Variegated.
236245. 'Magohachi'. Variegated.
- 236246 and 236247.** CAMELLIA SINENSIS (L.) Kuntze Theaceae. **Tea**
236246. 'Microphylla'.
236247. 'Rosa' ('Beni-bana-cha').
- 236248 and 236249.** THUJOPSIS DOLABRATA (L.f.) Sieb. & Zucc. Pinaceae.
False-arborvitae.
236248. 'Nana'.
236249. 'Variegata'.
- 236250.** TRACHELOSPERMUM ASIATICUM Nakai Apocynaceae.
'Hatuyuki-katura'. Leaves of several colors.
- 236251.** VIBURNUM ODORATISSIMUM Ker. Caprifoliaceae. **Sweet viburnum.**
'Variegata'.
- 236252 to 236254.** ZELKOVA SERRATA (Thunb.) Makino Ulmaceae. **Sawleaf zelkova.**
236252. 'Fui-keaki'. Variegated.
236253. 'Shidare-keaki'. Weeping.
236254. 'Tukumo-keaki'. Dwarf.

236255 to 236265.

From Japan. Plants collected by J. L. Creech, agricultural explorer, Plant Introduction Section, Horticultural Crops Research Branch, Beltsville, Md. Received Jan. 3, 1957.

I have already provided links to some **Cultivar Registration Forms** that have specific florimetric descriptors in particular. If you work in cultivar-level taxonomy, a study of every plant society or ICRA's formats is in order. When the International Coleus Society (ICS) set about in 2013 to develop their own form it had to meet some modern computer criteria that some day soon will seem very common and boring. The [ICS Cultivar Registration Form](#) covers many descriptors and topics. We asked some atypical questions like award won, trials where cultivar can be seen, Google Maps location of plants ready for public to visit, cultivar fingerprinting done, and both promotional and sales links. Then it was a bit of a new thing to have all this:

1. Easy fill-out form (check and text boxes both) with an online website link (we chose 123formbuilder.com and recommend them highly)
2. Image capable in terms of supportive color chips (basic colors), cultivar group leaf shapes, and other helpful examples
3. Email notification to our address of a completed form with easy download

4. Ease of handling website links, email addresses, and other special content
5. Ability to attach images
6. Ability to attach files such as PDF articles or catalogs
7. Ability to map location of garden examples of the cultivar (Google Maps)
8. Simple statistics (ie. 42% of registration all of this cultivar group, 21% of regs with this habit, etc.) plus opportunity for advanced analytics later
9. Easy conversion to database formats once the registration become large.

Because 91% of our new cultivar submissions came through email text, OROC (Open Registration Of Cultivars) developed the **OROC Cultivar Registration Long Form II** that covers woody plants in all genera. **Multi-generic Cultivar Registration Forms** can get complicated, long, and crazy a\$\$ detailed in a hurry. But we do what we need to do to elicit facts. There are many fine points in terms of descriptors and by reading the questions below you will hopefully see we covered all the bases and then some. It is a very long form but one we think helps draw out and demand information that is necessary to delimit cultivars, clarify the registrant's rights and intentions, and ultimately puts the new cultivars in it's best, most distinct light in comparison to the competing cultivars. We worked very hard to provide examples and explanations in parentheses and that is something very few ICRA type forms will do. In asking for more data than most originators have we are not discouraging registrations but helping to make us all think and analyze with more clarity why the cultivars is different or not. That said, our followup acknowledgement of the email (and we promise 48 business hours unlike...you know) we may ask some other questions. But we in OROC never charge a fee, demand a plant, require an image (and if you share one you keep the copyright notice), nor apply silly rules not in the code or among the best practices in the ICRA realm. And OROC always holds your hand, even if you're a grown up Ph.D., to help by doing all the taxonomic niceties, traditions, and frankly silly conventions to get your cultivar presentation just right. By the way, this form is optional and we'll accept a link to your catalog, your cultivar release page, and anything else that gets us the right amount of data.

Species and genus name:

Any infraspecific affiliation (ie. subspecies chinensis, botanical f. alba, var. hatchii, var. jonesii x var. smithii):

Cultivar name:

Significant of cultivar name (name for friend or relative, place where sport found, my garden name):

Do you have permission to use the name if after a celebrity, famous person, place, or product?:

It is hard to sell a plant that repeats a trademark or protected asset (Coke, Elvis, Big Mac, Mercedes) in some countries. Is this a concern?:

Patents or Breeder's Rights?

If so: USPP# and date:

Canadian Patent# and date:

Euro PBR# and date:

Other Patent# and date:

Since Latinized words are permitted in unregistered trademark names, would you consider adding this "old school" nomenclature?"

Trademarked (specify registered, unregistered)?

In what countries is the trademark registered?:

Was the trademark unregistered at first and later registered or it being sought now?:

Trademark Name for this one clone or taxon (ie. GREEN MAGIC® 'JMmagic')

Trademark Name for a group of cultivars (ie. NIRVANA® 'Heavenly Blue')

Does this trademark group name apply to more than one genus?

Significance of trademark name (ie. NIRVANA® is the name of the family garden)

Originator's name:

Originator's affiliation (ie Metropolis University, Frigid Experiment Station, Damncold, North Dakota):

Registrant's name (who is submitting this):

Registrant's affiliation (if different from originator):

Nominant's name (who named it, if different):

First commercial introducer (who first sold it or distributed it):

Patent assigned to in the body of the application:

First place of valid publication in print book (ie. Doe, J. 2021. Golden Trees. Metropolis Press, p, 43-44):

First place published on internet:

Associated with any particular fund-raising, charity, or special cause?

Do royalties go to one of these causes (share any details you like):

Is another nursery introducing it for you?:

When was it discovered (year):

First year or date of commercial sales and by whom? (ie. Doe Nursery, Metropolis, Ohio, 2011):

Has it been published in a printed catalog (ie. Doe Nursery Fall-Winter 2023 Catalog):

How did it occur (seedling, sport, controlled cross, wild):

If sport, name parent cultivar if known:

Did this cultivar come from a witches broom?:

If seedling, give history of source (ie. John Doe #JD3021 collected at 8000 ft. at Mt. Dido, Szechuan, China in 1988, notably fruitful tree with arker leaves):

Is from a notable tree at a particular garden, nursery, park, collection, etc? (ie. #76-203 from Metropolis Arboretum)

Parent taxa if hybrid (female x male, female parent if pollinator is unknown):

Height and width (specify 5 or 10 years or original plant with it's age)(10-12 ft tall x 4-5 ft. wide, 10y):

Habit form (ie. globose, fastigate, pendulous, decumbent):

Secondary branchlet form (ie. apex fasciated, columnar overall but secondaries semi-pendulous and filiform):

Special branching patterns (ie. self-branching, distinctly plumose, filiform/thready, densely tufted, virgate/snake-type):

If you have cladometric data (useful for Juniperus, Thuja, Chamaecyparis)(ie. 5-9 secondary shoots, longest 7-12 cm long, 2-4 tertiary shoots, longest 3-5 cm long, 0-2 quarternary shoots, longest 0.0-1.8 cm long) enter it here:

Growth rate per year (range as young stock):

Internode spacing (ie. 2-3cm or 0.5-0.75 in.):

Special landscape uses (ie. ecological reclamation, wildlife food, hedge, rock garden, fast windbreak, collector's item):

Unique habit features (ie. stronger crotch angle, no staking required, no fruit so keep dense form):

Bark showy? (yes, no):

If bark showy, describe colors and pattern (ie. corky to 5cm thick, white exfoliating brown by 3rd year, orange similar to orange winter twigs):

Stem or twig traits, if unique or showy (ie. alate/winter to 3cm deep, showy orange winter stems, thornless twigs, twigs red striped white 1st year):

if flowers dimorphic (ie. fertile and sterile, describe each separately below):

If flower bicolored or tricolored describe pattern (ie. picotee, eyezone, flecking, suffusions or tints):

If flower bicolored or tricolored describe distribution (ie. red picotee 10% surface, pink throat 10%, base color white 80%)

Flower scent, only if atypical or variable in species (ie. light fruity scent, unscented, unique strong bubblegum aroma):

Flower bud color (specify corolla, calyx, bracts, etc.)(ie. red buds open blush, white at maturity):

Flower color (corolla, main mature color, use RHS, RBG, or Pantone values when known):

Flower color (corolla, fading color):

Flower color (calyx or bracts):

Flower color (pedicel/stalk):

Flower corolla lobe shape (ie. suborbicular, broadly ovate, irregularly notched and undulate, convex and elliptic-ovate):

Flower corolla shape (only if atypical, ie. campanulate, funnelform, rhomboid):

Flower corolla length and width (diameter) (specify in, cm, mm):

Bloom period (give location, ie. July 15 to September 5, Raleigh, North Carolina):

Is it unusual for blooming earlier or sooner or young plants?:

Rebloom (under what conditions, ie. partial 5-10% fall rebloom if cut back in September after peak):

Other floral traits (ie. self-deadheading, lacks petals, incised petals, heads born well above foliage):

Petal or tepal count (only if atypical):

Inflorescence shape (ie. domed panicle, flat cyme):

Inflorescence dimensions (specify cm or in)

Can this plant be described as an dual purpose "edible-ornamental"?

If a conifer, use the "fruit" traits below to describe any ornamental female strobili (cones)

Fruit showy?:

Fruit edible?, if so describe:

Fruit shape, describe if atypical (ie. elongated ellipsoidal to narrowly ovoid while species is broadly ovoid):

Fruit color, if showy (ie. gold tinged red, green becoming blue and later black):

Fruit dimensions if showy (in, cm, length x width):

Special fruit traits (ie. fruitless, early fruit by September 15 (GA), pods showy and red):

Leaf polymorphic (2 or more distinct shapes or forms)?:

Leaf shape and type (ie. palmately 5-lobed, cordiform and unlobed, omit if typical of species):

Leaf dimensions (long x wide, average, cm):

if you have more phyllometric data enter it here (useful for Hedera, Acer)(ie. 3-5 secondary lobes, 2.3-4.1 cm long, 1.1-1.5cm wide; 1-2 tertiary lobes, 1.1-1.3 cm long, 0.5-0.7 cm wide, tertiary lobes rarely absent in 2-4% of blades measured):

Leaf lobe count:

Leaf color (new tips, immature)(ie. showy red to orange tips becoming light olive green, finally a dark olive green):

Leaf color (above when mature)

Leaf color (below when mature, if conifer describe stomatal banding):

Leaf color (fall):

Leaf color (winter or cold weather):

Leaf vein color (describe if contrasting, reticulate)(ie. veins distinctly silver, veins a slightly green but not showy):

Leaf petiole (special, atypical traits only)(ie. 1.0-1.6 cm long, shorter, distinctly pink to red, very showy with the gold lamina):

Is the leaf multicolored but not truly variegated (a section lacking chlorophyll)(ie. green suffused red, tinged orange with greener veins):

If variegated leaf, is it bicolored, tricolored in general, or more?:

If variegated leaf, pattern (ie. marginate, central zone/medio-picta, speckled/maculata, margino-maculata):

If speckled or maculata variegated are there tiny flecks, large spots, and big sectors?:

If marginate variegation is there a central "tree" or "leaf" shape (describe it):

If variegated leaf, chimera % of entire surface (ie. marginate 25-45% surface):

If variegated leaf, color of chimera (ie. pink becoming cream with maturity):

Leaf vestiture (hairs or trichomes, describe only if atypical)(ie. more tomentose than species, glabrous below unlike 'Pendula'):

Leaf base type (ie. broadly cuneate, shallowly cordate to truncate):

Leaf apex type (ie. acuminate, obtuse, acute, cuspidate):

Leaf margin type (ie. crenate, incised, serrate, dentate):

Leaf margin undulates (if atypical, describe # of waves and depth per side of leaf):

If spinose marginal teeth (ie. Ilex, Osmanthus, Mahonia) describe # of teeth per side:

If spinose marginal teeth (ie. Ilex, Osmanthus, Mahonia) describe length and wide of teeth (in, mm):

If spinose marginal teeth (ie. Ilex, Osmanthus, Mahonia) describe spacing between teeth (in, cm):

If incised or cut, estimate depth of cut or lobing in %:

Any special leaf traits (more glaucous than cultivar X, thicker blade, showy red petiole):

if leaves edible, note any special chemistry (ie. 12% thymol, more potent for culinary use than 'Big Red'):

Cold hardiness (USDA number and/or degrees, if atypical and compare)(ie. USDA 4a compared 5a for 'Grandiflora Alba'):

Any special pest or disease resistance (give specific names):

Any special cultural resistance (ie. urban resistant due to higher drought tolerance and thicker leaves):

Any laboratory proven physiological improvements (ie. 26% higher photosynthetic efficiency compared to 'Viridis Nana'):

Propagation notes: (ie. roots up to 97% from softwood cuttings, best crafted on resistant 'Rootuff' understock):

Non-invasive clone (ie. triploid, fruitless, sterile seed)?:

Genetics/cytology (ie. ploidy, unique traits):

Has the cultivar been DNA profiled by a qualified or certified lab (if so, where on file):

International awards (ie. RHS AGM 2012, Plantarium Gold Medal 2021, Plantus Society Plant of the Year 2020):

This cultivar was bred mainly to remove certain flaws of the species other cultivars?:

Cultivar is designed to replace existing cultivar (name it)(ie. sterile 'Green Goblin' type, mildew resistant 'Red King'):

Compare and contrast to existing Cultivar A (name it):

Compare and contrast to existing Cultivar B (name it):

Compare and contrast to "species typical" of gardens:

Are any traits completely new to this species or genus (ie. first lavender-flowered clone, first genetic dwarf)?:

Is this a unique combination of two or more existing traits (ie. weeping/gold, dwarf/white-flowered, first gold-leaved dwarf with true red flowers)?:

Why is it unique and special in general?

Any quotes from evaluators (name or not) describing it ("best white-flowered clone we have tested" John Doe, Metropolis Nursery):

Internet video link for it's promotion (please do not attach video files to email):

Sales email to purchase it (specify if wholesale only):

Informational email to discuss (if contact is invited by any reader):

Sales internet link to purchase it (specify if wholesale only):

Informative internet link with more details (including cultivar release, academic article):

Public garden or nursery where it can be seen by public (attach Google map or other link if desired):

Image link on internet:

Image for registration form (please attach up to 10MB and your copyright statement, this is OPTIONAL):

Any other information our readers might like:

CHAPTER TWENTY-ONE

CULTIVAR-LEVEL TAXONOMY OF INTERIOR, FOLIAGE, AND HOUSE PLANTS

Henny, R.J. and Chen, J., 2004. Cultivar development of ornamental foliage plants. Plant breeding reviews, 23, pp.245-290.

https://www.researchgate.net/profile/Jianjun_Chen8/publication/230481766_The_Foliage_Plant_Industry/links/5714d42e08aec4e14da7f462.pdf

This is a very important paper in the study of cultivar selection and breeding of house plants and the two authors are both legends in the field. This paper covers so much of their knowledge and it spans quite a few genera. They did some earlier papers on the topic but this is a great start.

Rout, G.R., Kullu, J., Senapati, S.K., Aparajita, S. and Mohapatra, A., 2007. Identification and Genetic relationship among Polyscias and Schefflera (Araliaceae) using RAPD and ISSR markers. Plant biotechnology, 24(5), pp.519-525.

https://www.jstage.jst.go.jp/article/plantbiotechnology/24/5/24_5_519/_pdf

14 Polyscias and 1 Schefflera with RAPD and ISSR are employed. Schefflera clustered away.

Jafri, S., 1979. Taxonomic and morpho-anatomical studies on variegated plants I: Polyscias balfouriana Bailey (Araliaceae). Proceedings of the Indian Academy of Sciences-Section B. Part2, Plant Sciences, 88(3), pp.195-201.

<https://www.ias.ac.in/public/Volumes/plnt/088/03/0195-0201.pdf>

codaeum

<https://journals.ashs.org/hortsci/view/journals/hortsci/45/6/article-p868.xml>

Chen, J., Henny, R.J., Devanand, P.S. and Chao, C.T., 2006. AFLP analysis of nephthytis (*Syngonium podophyllum* Schott) selected from somaclonal variants. *Plant cell reports*, 24(12), pp.743-749.

http://www.academia.edu/download/48547673/AFLP_analysis_of_nephthytis_Syngonium_p20160903-9823-1u01sle.pdf

Syngonium are sorted out to a wonderfl degree although today we have 150 cultivars and that makes things more complicated still.

Chen, J., Devanand, P.S., Norman, D.J., Henny, R.J. and CHAO, C.C.T., 2004. Genetic relationships of *Aglaonema* species and cultivars inferred from AFLP markers. *Annals of botany*, 93(2), pp.157-166.

<https://academic.oup.com/aob/article/93/2/157/286556>

Boyce, P., 2004. A review of *Epipremnum* (Araceae) in cultivation. *Aroideana*, 27, pp.199-205.

https://www.researchgate.net/profile/Peter_Boyce2/publication/308503215_A_Review_of_Epipremnum_Araceae_in_Cultivation/links/57e4fb1008ae25aa020b6646.pdf

Epipremnum cultivars and many not described elsewhere.

Nannenga-Bremekamp, N.E., 1970. Notes on *Hedera* species, varieties and cultivars grown in the Netherlands. *Meded. Bot. Tuinen Belmonte Arbor. Wageningen*, 13, pp.195-212.

<http://edepot.wur.nl/274080#page=198>

Yes, there are great ivy books out there but Nannenga-Bremekamp in 1970 dared to do the impossible for any ornamentals taxonomist: write a sane, practical, sufficient precise, and comprehensive key to *Hedera helix* cultivars. That is close to the Holy Grail of house plant taxonomy and he actually pulled it off due to his intimate, intense knowledge of the cultivar variation. This is a much overlooked paper and still very useful today.

Osuji, J.O. and Nwala, P.C., 2015. Epidermal and cytological studies on cultivars of *Xanthosoma* (L.) Schott. and *Colocasia* (L.) Schott. (Araceae). *International Journal of Plant & Soil Science*, pp.149-155.

TANIMOTO, T. and MATSUMOTO, T., 1986. Variations of morphological characters and isozyme patterns in Japanese cultivars of *Colocasia esculenta* Schott and *C. gigantea* Hook. *Japanese Journal of Breeding*, 36(2), pp.100-111.

https://www.jstage.jst.go.jp/article/jsbbs1951/36/2/36_2_100/_pdf

CHAPTER TWENTY-TWO

ANATOMY IS GOOD FOR CULTIVARS BUT

MORPHOLOGY + ANATOMY IS SOMETIMES ENOUGH AND

MORPHO + ANATOMY + CHEM IS OFTEN BETTER

In some cases a classic study of morphometrics combined with a big of wood, stem, cell, meristem, or epidermal anatomy does the trick to get some good, solid, reliable taxonomic separations. These are not necessarily easier than cytological, DNA and chemotaxonomic work because it still means hundreds of hours with a microscope and sometimes all the preparation required for **SEM (Scanning Electron Microscope) analysis**.

Here will be some studies of ornamental, garden taxa where the anatomy got the morphology to a better place by looking closer and measuring smaller, definitive traits. Call it **morphoanatomy** if you will and some have.

Dempsey, D. and Hook, I., 2000. Yew (*Taxus*) species-chemical and morphological variations. *Pharmaceutical biology*, 38(4), pp.274-280.

[https://www.tandfonline.com/doi/pdf/10.1076/1388-0209\(200009\)3841-AFT274](https://www.tandfonline.com/doi/pdf/10.1076/1388-0209(200009)3841-AFT274)

This study measured both leaves and stomates in 5 *Taxus* species and 25 *Taxus baccata* cultivars. The differences among the cultivars seemed more solid than between the species, likely because the cultivars have a very diverse set of vegetative mutations and the species pretty much look alike for basic leaf and foliage formation. Needle length, needle width, needle area, stomatal pore length, stomatal number, and paclitaxel content (adding some chemotax work too) were all helpful as the best descriptors or traits. The odd 'Adpressa' had tiny leaves (7.7 x 1.9 cm) while the massive-bladed 'Elvastinoensis' (22.4 x 2.1 cm) covered the extreme side of *T. baccata*.

Compare this above to:

Spjut, R.W., 2007. Taxonomy and nomenclature of *Taxus* (Taxaceae). *Journal of the Botanical Research Institute of Texas*, pp.203-289.

<http://www.worldbotanical.com/TAXNA.HTM>

This author has his own website with all this information and more. The loads of herbarium scans and whole plant images from both the wild and cultivation is extremely informative and valuable. If you are used to the classic yew taxonomy, his views may make your brain explode but perhaps all for good. The logic is fairly solid (very detailed keys are pretty clean and functional) in most cases but making a variegated mutant a wild var. *variegata* is questionable. The main, familiar garden taxa from Europe are now split into the *Taxus baccata* Alliance, *Taxus fastigiata* (Irish Yew types which do exist in the wild we think), *Taxus recurvata*, *Taxus caespitosa*, and *Taxus umbraculifera*. The familiar Hicks Yew (*T. x media* 'Hicksii') from Hicks Nursery on Long Island c. 1923 is considered *T. umbraculifera* var. *hicksii* (Rehd.) Spjut, a selection from Japanese seed and thus consider an indigen nor a cultigen. To further this conclusion, vouchers collected in Japan are cited and I do see the similarities. *Taxus cuspidata* 'Nana' is now assigned to *T. umbraculifera* var. *nana*, again with proof of wild origins and specimens cited from Japan., Russia, and China, noting that Ohwi in his flora in 1965 found something very similar along the seashores of Japan. 'Hatfield' belongs to this var. *nana*.

Šarić-Kundalić, B., Fialová, S., Dobeš, C., Ölzant, S., Tekel'ová, D., Grančai, D., Reznicek, G. and Saukel, J., 2009. Multivariate numerical taxonomy of *Mentha* species, hybrids, varieties and cultivars. *Scientia Pharmaceutica*, 77(4), pp.851-876.

<https://www.mdpi.com/2218-0532/77/4/851>

I particularly like this study since it included a wide range of morphological, anatomical, and chemical traits and they figured out what sets of descriptors worked best. *Mentha x gracilis*, *M. x villosa* and *M. spicata* var. *crispa* were close. *Mentha x gentilis* has been considered a synonym of *M. x gracilis* but their material showed *M. x gentilis* proved distant and much closer to *M. spicata* subsp. *spicata*. The tough part of garden mint taxonomy is that the female and male parents of some hybrids, whether hybrids species or just groups, may not be typical of their own species in terms of chemistry. When atypicals cross...you get mints.

Nonić, M., Jakanović, D. and Knežević, R., 2012. Comparative research of size and number of stomata of different beech cultivars. In *International Scientific Conference Forests in Future-Sustainable Use, Risks and Challenges*. Institute of Forestry, Belgrade (Serbia).

I'd love to read this article if anyone can lawfully share a copy.

Konarska, A., 2007. The comparison of nectaries structure of some varieties of ornamental apple. *Acta Agrobotanica*, 60(1).

http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.agro-article-bc5445b3-de63-4ea9-a14f-99580b4ff2c9/c/1739-4264-1-PB_35.pdf

Lanzhi, Z., 2008. Study on leaves stomata of Different Ornamental Pumpkin Varieties [J]. Journal of Henan Institute of Science and Technology (Natural Sciences Edition), 2.

CHAPTER TWENTY-THREE

CULTIVAR LEVEL TAXONOMY OF HARDY GARDEN PERENNIALS

Let's start with the basics, a review of some earlier content. The RHS and Chicago cultivar trials are essential to understanding the new cultivars and species affinities. ISU-perennials.org in the Europe is doing some amazing work too. The European Garden Flora has some of the best perennial keys out there if you can afford or find it. My own [Hatch's Perennials \(HP\)](#) is intended to be the most complete encyclopedia of described, not just name listings, of perennial cultivars in existence. and after 40 years I am entitled I hope to brag on it some. Or as Will Sonnet in the famous western TV series was fond of saying: not bragging, just fact. HP was 108 Ajuga cultivars, 191 Astilbe, 81 Bergenia, 362 Campanula, 68 Baptisia, 182 Geum, 66 Cortaderia, and that is just a quick listing. I would not have invested thousands of hours and untold tens of thousands of dollars if it a better cultivar file for perennial were not needed and absolutely essential.

Okuno, H., Nakata, M. and Mii, M., 2011. Stable chromosome number in horticultural cultivars of *Farfugium japonicum* (Asteraceae), with descriptions of their morphological characteristics. *Chromosome Science*, 14(3+ 4), pp.53-62.

https://www.jstage.jst.go.jp/article/scr/14/3+4/14_53/_pdf

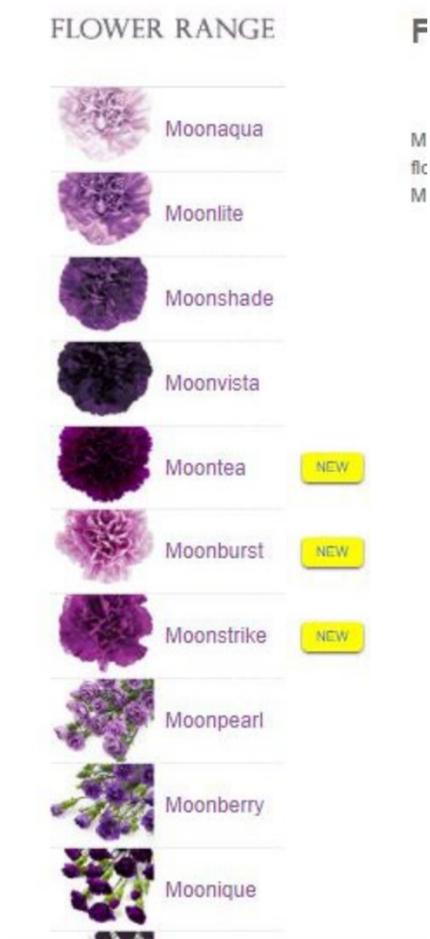
I wanted to start with this paper as it simply blew my mind. 111 different *Farfugium* cultivars not only described but also vouchered, leaf photos, cytological stains, chromosome numbers, and pollen stainability (an issue in this hard to breed genus). Wow, wow, and wow again.

From about 2010 on, I made sure **Hatch's Perennials** was formatted in PDF for use on any phone or tablet. This is clearly an older phone but I shows me reading up on Agave cultivars while in a garden. Descriptions and images are good but even nicer on a tablet. One reason I resisted taking the data back to a database format is that PDF encyclopedia are much easier to use on a portable device than using a stylus or pinkie finger to select criteria from a set of boxes in a tiny font.



CHAPTER TWENTY-FOUR

TAXONOMIC UNDERSTANDING OF TRANSGENIC AND GMO ORNAMENTALS



A range of new carnation colors. Image courtesy of florigene.com

Like any history of anything there is a blur doing it's early days and it will likely be corrected later. Not everyone doing working with genetic modification of ornamentals will publish it, admit it, patent it, or sell it. Quoting Dr. John Hammond of the USDA, we believe the first true transgenic ornamentals to be Agrobacterium-mediated change to Chrysanthemum by Courtney-Gutterson and partners around 1994 while Kamo and colleagues used particle bombardment (biolistic) to change Gladiolus around 1995. Direct DNA occurred with orchids and some other genera around 1995 or perhaps a bit later. Roses, mums, orchids, glads, and carnations are the first recipients of new DNA. Hammond says the first commercially sold transgenic ornamental seems to be the Moon Series carnations from [Florigene](http://florigene.com) in Australia which introduced internally developed blue and purple pigments to the flowers. <https://naldc.nal.usda.gov/download/25775/PDF>

At the risk of offending, there is much more to transformed ornamentals than a rose that self-identifies as a Petunia or pine tree; or a dwarf conifer born in the body of a holly.

So what are we getting in terms of common phenotypes of interest to the average consumer and gardener? Some of them that are proven in at least one genus include:

1. New flower pigmentations (ie. blue *Dianthus carophyllus*, true blue or black roses)
2. New leaf colors (red-bladed Petunia)
3. New plant habits, branching, and architecture (Ls=less branching gene for mums, lpt=increased branching/shorter internode gene in mums)

4. Improved pest and disease resistances (various, including virus-resistance, blackspot resistant roses)
5. Ethylene insensitivity (longer cut flower life in several species)
6. Herbicide resistance (the whole Monsanto and Bayer game, indoors and out, corn and now turf, soon everything)
7. New floral scents or giving unscented species a pleasant scent
8. Foliage color improvement, perhaps lack of early senescence is delayed yellowing in mum leaves
9. Alteration of flowering season or time to bloom from explants
10. New floral morphologies (flower development genes, suppression of reproductive parts with messy pollen and fruit production). This could reduce invasiveness by adding sterility, lack of fruiting, reproductive parts, etc. One orchid gene called MADS-Box turns the second round of petals into a calyx.
11. Improved hardiness or frost tolerance (Petunia gets a longer season)
12. Glow-in-the-dark plants (flowers and foliage both, just like those fish)

As a taxonomist what all this is telling me is that the traits I rely on to tell one species from another or even genus to genus are being eroded with barriers broken by the day. When the basic floral and foliage morphology are changed radically the underpinnings of taxonomy are coming apart. But I am not worried. Yet. The consumer who spends billions on flowers and landscape plants usually wants to know what species or "kind of thing" they are paying for. So far, there is no demand for "pretty blue flower that blooms all summer and is hard to kill". My bad. There is such a demand and a big one. If you think all the multi-generic orchid hybrids make life complicated, we are soon to have perennials, house plants, and even trees which span the genes of several unrelated genera and are a mix up of the genes. It is almost like one of those video games where you can breed your own plant and it doesn't have to make sense or have any basis in reality. Point and Shoot, the plant breeding gene game.

CHAPTER TWENTY-FIVE

NEW AND RADICAL NOMENCLATURAL CONCEPTS FOR ORNAMENTALS

Hettterscheid, W.L.A. and Brandenburg, W.A., 1995. **Culton versus taxon: conceptual issues in cultivated plant systematics. *Taxon*, 44(2), pp.161-175.**

https://www.researchgate.net/profile/Wilbert_Hettterscheid/publication/273071974_Culton_versus_Taxon_Conceptual_Issues_in_Cultivated_Plant_Systematics/links/5500a6e30cf2de950a6f9c74.pdf

Apparently Dr. Chris Brickell, former Director of the RHS coined or at least revised the term **culton** (plural *culta*). The idea was to create a new nomenclatural entity, no, no, not a new taxon, but something separate from the botanical hierarchy and much more practical and flexible. It would be a separation from not integration with botanical systematics, cultivar and cultivar group both but yet neither. The idea arose from the question: "are groups of cultivated plants really taxa?". Yes and no. Let's for argument say no. Cultivars are mixes of natural and manmade processes and not evolution per se. They are man-mediated evolution though man is truly part of nature, a very big part in fact. Manmade things are unnatural but just the product of nature's most dominant, intelligent, and perhaps invasive species. The culton is useful in **non-hierarchical or open classifications**. The culton can be part of botanical taxonomy at whatever level you need those taxa, a culton of the genus (infraspecific entity), species, botanical variety, or what ever hierarchy you require or don't require. No one is saying cultons have no species affinity but they don't need all it's baggage in terms of infraspecific hierarchies. Cultivars are no more below the forma or subforma in the realm and role of things because so often they don't fit. For one example:

Brassica oleracea WHITE-HEAD CABBAGE GROUP (a proud culton) = B.o. subsp. oler convar. capitata var. capitata f. alba (old, botanocentral taxonomy)

One reason I like the culton is pure genetics. Technically, *Fagus sylvatica* 'Rohan Weeping' (a cut-leaved, purple weeper) belongs to *F. sylvatica* f. *pendula*, f. *atropurpurea*, and f. *laciniata* all at once. It is only partly cut so it's intermediate to f. *sylvatica* too. It spans the forms which are all reported in the wild and solid taxa there. There is no one cultivar group to house it either for it's unique combination of things that genetics makes possible. There is no botanical hierarchy below the level of species to house it or even briefly contain it! I would be inclined to name a new culton *Fagus sylvatica* PAL Group for the combination of these three major traits. AF Group would be purple to red columnars (several named clones, 'Fastigiata'=F) and PZ Group the weeping gold 'Aurea Pendula' (Zlatia being the classic gold cultivar). This way we'd get or could construct with ease enough groups to hold all the major combinations for habit, leaf margin, and leaf color. Think about it.

Misc. resources to be categorized later

AA J: <https://www.biodiversitylibrary.org/bibliography/480#/summary>

Arnoldia: <http://arnoldia.arboretum.harvard.edu/>

Arnoldia cv reg

PVL=Plant Variety Licensing sights at u niv source of stand

Rossatto, D.R., Casanova, D., Kolb, R.M. et al. *Plant Syst Evol* (2011) 291: 103. <https://doi.org/10.1007/s00606-010-0366-2>

Fractal analysis of leaf texture

<http://natuurtijdschriften.nl/download?type=document;docid=541044>

tulipa class with biometrics PCA

Flowering date 0-365 (16) -0-761 (2) -0144 (21) 242-064 43-269 Plant length 0-297 (21) -0-826 (1) -0-122 (22) 102-231 15-653 Stem diameter -0-471 (11) -0-417 (7) 0-455 (4) 31-840 5-275 Stem pubescence -0-629 (1) 0-028 (27) 0-039 (24) 82-689 25-467 Leaf width (2nd) -0-337 (19) -0-584 (4) 0-506 (3) 68-704 9-692 Leafwaviness 0-532 (8) -0-251 (13) -0-248 (14) 90-999 13-063 Leafposition 0-275 (22) - 0-484 (6) -0-221 (15) 41-721 6-524 Leafpubescence - 0-524 (9) -0-206 (15) 0-025 (27) 110-390 88-450 Outer tepal length - 0-570 (5) -0-325 (8) -0-315 (8) 161-388 12-083 Outer tepal width -0-451 (13) - 0-602 (3) 0-450 (5) 76-547 15-689 Outer tepal pubescence -0-578 (4) -0-224 (14) -0-163 (19) 32-732 89-932 Tip inner tepal pubescence 0-006 (29) - 0-480 (5) - 0-342 (7) 119-275 65-431 Blotch length at centre - 0-565 (6) 0-021 (29) 0-184 (16) und. 3-435 Blotch length at margin - 0-586 (3) 0-117 (17) 0-276 (13) und. 6-570 Tunic hairy at base -0-543 (7) -0-104 (19) -0-582 (2) 47-250 7-801 Tunic hairy at centre -0-522 (10) - 0-033 (26) -0-665 (1) 49-027 7-909 Tunic hairy at top

Poinsettia Trials db (NCSU)

<https://trials.ces.ncsu.edu/poinsettias/>

232 CVS grp by bract color, color grp (ie. marble, red, peppermint, vigor, timing, breeder, image

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Please link only to www.cultivar.org for reference to this page