Chestnut Growers of America

The Chestnut Grower

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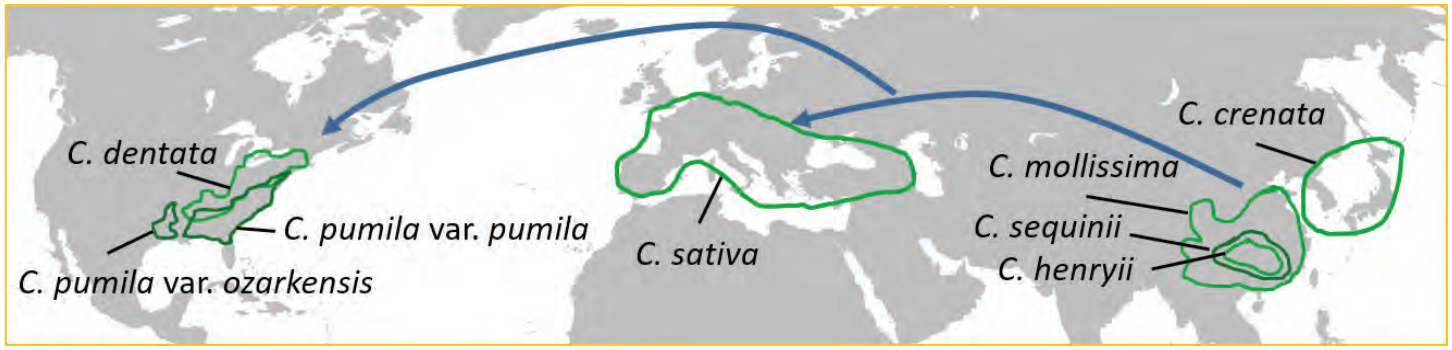

Approximations of the native ranges of Castanea *species, showing the migration of chestnuts into Europe and North America before humans appeared.*

Ancestry Informative DNA Markers for Chestnut: Why we need them and where we are now

By Jeanne Romero-Severson, Professor, University of Notre Dame, Notre Dame, IN | jromeros@nd.edu

The genetic history of chestnuts in North America is complicated. DNA analysis has shown that *Castanea* in the Middle East, Europe, and North America are the descendants of East Asian chestnuts.[1] Chestnuts migrated on their own to North America before the continents separated and long before humans appeared. Humans domesticated the European, Chinese and Japanese chestnuts. Our ancestors were no different from today's growers. They would have traded seed and cuttings among themselves and even traded cuttings along the great Silk Road trade routes from China to the Middle East and beyond.

Improving chestnuts – the classic way

Chestnut improvement has always been done by individual growers, from ancient times until the present. Thousands of years of growing experience in China, the Middle East, and Europe produced local populations and cultivars that met local expectations for local markets. There is no hard evidence that the native people in North America domesticated chestnuts, but they may have assisted the northward migration of American chestnut as the glacier retreated.[2]

When the English and French colonists arrived in the Americas, they brought their love of chestnuts with them. Thomas Jefferson, born in Virginia to English colonists, and the author Pierre Samuel du Pont de Nemours imported European chestnuts and crossed them with American chestnuts in hopes of creating new chestnut cultivars[3].

In the 19th century in the eastern United States, nurseryman S. B. Parsons of New York and others imported Japanese chestnuts for direct sale to growers while the gold rush in California attracted migrants who brought their European chestnuts with them. Growers hybridized the Japanese chestnuts with American and European chestnuts to produce chestnut cultivars, some of which could be the ancestors of cultivars in your orchard.

In the early 20th century, breeding programs focused on developing blight-resistant chestnuts included American chinquapins (*C. pumila*) and Chinese chestnuts. Now crosses with interspecific ancestry from more than two species were made, either deliberately or accidentally and many of these seedlings were shipped throughout the United States. When interest in the production of chestnuts as a fresh market crop revived in the 1970s and 1980s, growers had a collection of

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The Chestnut Grower

January 2018

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Deadlines

Issue	*Deadline*	*Mailed*
Winter	Dec. 10	Jan. 1
Spring	Mar. 10	April 1
Summer	June 10	July 1
Fall	Sept. 10	Oct. 1

Editorial Opinion

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Message from CGA President Roger Blackwell, Chestnut Grower

Greetings Chestnut Growers of America Members,

I hope you all had a wonderful holiday season with family and friends and are looking forward to the coming year.

Our annual meeting this year will be hosted by Luke Wilson in Gridley, California, and I know Luke is planning a great session. Some details can be found in this newsletter, with more coming in the spring issue.

In continuing the focus on improving chestnut orchards, Dr. Jeanne Romero-Severson will be presenting an update on the Ancestry Informative Marker Set (AIMS) for chestnuts project, as an update to the talk she gave at our last annual meeting about keeping track of our "stuff" (chestnut trees) in our orchards.

For this newsletter, Professor Romero-Severson has put together an excellent overview of the AIMS project. We as growers need to submit samples of our chestnut trees to verify identity of breeding. In order to have quality chestnuts for market, we need and now will have an affordable, transferable technology for advancement of chestnut genetics and identification. Greg Miller has also contributed a great article that introduces how the AIMS project will be most useful in the context of a cooperative breeding program for chestnuts.

I hope you find the rest of this newsletter has something informative and educational about, as always, growing and improving your chestnut orchards.

Rita Belair, editor for CGA, has done an excellent job in making our quarterly editions educational and informative for chestnut growers by CGA members. Please continue providing her with new articles to add to future CGA newsletters.

The purpose of CGA is to promote chestnuts, to disseminate information to growers of chestnuts, to improve communications between growers within the industry, to support research and breeding work and generally to further the interests and knowledge of chestnut growers. Thank you all for your contributions to CGA.

See you all in Gridley, California in June 2018.

Best Regards,

Roger

Happy New Year!

Your 2018 membership dues are now due. Please fill out and return the membership renewal form included with this issue.

You have two options:

Renew Online

Download a fillable form from the CGA website at www.chestnutgrowers.org/2018_CGA_Membership_Application_fillable.pdf. If you receive the e-version of the newsletter, the form is also attached to that email. Complete the form and email it to Jack Kirk, CGA secretary/treasurer, at jackschestnuts@gmail.com. You can then pay your dues through the CGA website by visiting www.chestnutgrowers.org/paydues.html. Please make sure you submit both your application and payment at the same time!

OR

Renew by Mail

Send a hard copy of the form with a check made payable to Chestnut Growers of America, Inc. to Jack Kirk, 2300 Bryan Park Ave., Richmond, VA 23228.

Grower Updates

2017 Chestnut Crop at Trails End Chestnuts, Washington State

Submitted by Lee Williams

The winter of 2016-2017 in Eastern Washington was a long cold one. We had snow on the ground for about 105 days. Can't say the total amount because it would melt a little and freeze over with an ice crust and repeated this cycle numerous times. I was drifted in twice. Everything from leaf buds to bloom was two weeks late for this area. It was after mid-June before blooming started. We had a good nut set, but during the last 4-6 weeks of optimum nut growth time, we had three weeks of dense smoke cover that settled in our basin from the many forest fires we had going in northern Washington and British Columbia and blocked out sunshine. It was bad enough to stop a lot of outside activities and cause numerous health advisories. My crop which is usually 10-15% smalls was about 40% plus this year. Total weight yield was down about 25%. We hand-pick our nuts, and due to the small size of nuts, our harvest cost was about up about 30% on a per pound basis. Then, to top everything off, we got a couple good early frosts and a related leaf drop that stopped harvest because of non-visible nuts under the leaves and subsequent related harvest costs. We also had three inches of snow during the first few days of November, which has never happened in the 45 years I have lived on this farm. Since ending harvest, we've had many cold and windy days with rain, as we know it. We've already had early November nights in the high teens. Our annual precipitation totals about nine inches a year but we do have adequate irrigation. I'd like to talk to the guy who wrote that stuff about some "inconvenient truth" thingy. Aah, such is the bane of agriculture, good old Mother Nature.

Mark your calendars for the Chestnut Growers of America 2018 Annual Meeting at Luke Wilson's ranch in Gridley, California!

Save the date:

June 1-3, 2018*

**The past couple issues of The Chestnut Grower included a save-the-date for June 8-10, 2018. Due to scheduling issues with the meeting venue, the board voted to change the meeting date to June 1-3, 2018. Apologies for any inconvenience!*

Luke Wilson, CGA board member, has graciously volunteered to host the CGA 2018 annual meeting at his ranch in Gridley, California. Make plans now to attend!

ON THE AGENDA

Friday, June 1

Fly into Sacramento (50-minute drive to welcome reception) or San Francisco (2½ - 4-hour drive to welcome reception, depending on when you arrive).

Welcome Reception at Wil-ker-son Ranch (4:00 pm - 8:00 pm)

661 E. Evans Reimer Rd, Gridley, CA 95948

Hotel options in Chico, CA (TBA)

Saturday, June 2

Annual Meeting at The Italian Guy Catering & Event Center (8:00 am - 4:00 pm)

28 Bellarmine Ct, Chico, CA 95928

Group brewery tour and dinner at Sierra Nevada Brewery

1075 E 20th St, Chico, CA 95928

Sunday, June 3

CGA Board Meeting

Farm tours around Gridley and Biggs, CA

- *Wil-ker-son Ranch*
- *Harrison's Chestnut Ranch*
- *Silva's Chestnut Ranch*

Registration and lodging information to follow in April.

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cultivars and populations of unknown ancestry and largely without reliable records of performance under difference conditions. Growers began to see that the existing cultivars could really use some improvement.

Improving chestnuts – using modern technology

What can be done that is quick, cheap, reliable, and immediately useful for improving chestnut germplasm? Identification of the ancestry of the most promising cultivars and progeny is a good start. Ancestry informative DNA markers (AIMs) have multiple uses: 1) to distinguish the eight species of chestnut, 2) to identify the species admixture of interspecific hybrids, 3) to identify close relatives (parents, sibs, grandparents, half-sibs), and 4) to record a unique genetic "fingerprint" for each genotype you think has promise as a cultivar. The real secret of good plant breeding is to pick the best parents, but to do this well, you need a performance history on your parents and a record of which combinations produce the best progeny. Lacking that, DNA fingerprinting a good place to start.

A first-generation interspecific hybrid may be easy to spot, but once hybrids are crossed with other hybrids and backcrossed with the parental species, interspecific ancestry may not be obvious. This ancestry can be the cause of really disappointing progeny from a really good seed tree.

A three species mix tree may be the best cultivar in your orchard, but this mix cannot be transferred intact to the progeny and some fertility problems may occur. Certain trees may be only average in terms of seed yield but are really good pollinators for certain other trees. Once chestnut growers have identified good combinations, it is essential to keep the identities straight.

"What can be done that is quick, cheap, reliable, and immediately useful for improving chestnut germplasm? Identification of the ancestry of the most promising cultivars and progeny is a good start."

How it works

Many of you have contributed cultivars and progeny to the AIMS project. Many of you may be wondering why this is taking so long. A project like this is like building a house. Grading the site, getting the utilities in, pouring the footings and getting the basement done takes time and must be done right, else none of the rest will be right. Identifying interspecific ancestry is tricky because chestnut trees grown from seed are different from one another, even if they are of the same species. This is similar to variation in dogs. Dogs are different from one another in some of their DNA sequence, even within the same breed. If I wanted a DNA test to tell me if my dog is part wolf or part coyote, it would not be enough to take DNA from my dog, one wolf and one coyote. I would have to get DNA samples from all the subspecies of wolves and coyotes, including a wide range of dog breeds.

Where are we now?

Members of the CGA, the NNGA, and the TACF have sent me chestnut twigs from many Chinese, European, Japanese, American, and American chinquapin chestnuts. We now have all eight species of chestnut as well. We have extracted DNA from all the twigs we have. Now we are screening hundreds of genetic markers from all the species of chestnut using a high-throughput technique that saves years of work. After the initial sequencing, the best ancestry informative DNA markers will be verified using an older technique that takes more time but is the gold standard in terms of accuracy. Then we will design a relatively inexpensive assay to determine the ancestry of individual trees. The high-throughput sequencing will be finished just in time for the Christmas holidays. In the first two weeks of January my student and I will pore over the data, pick the best markers and begin verification tests. By the end of February, we will have the first results to report to you. After that, we will genotype all the samples. Updates to come this spring and summer!

Chestnut Growers of America has contributed $10,000 to help fund the AIMS project research effort. You can contact Professor Romero-Severson about contributing chestnut twig samples at 574-631-3938 (office) or jromeros@nd.edu. Mailing address: 327 Galvin Life Science Center, University of Notre Dame, Notre Dame, IN 46556.

References

[1]Lang P, Dane F, Kubisiak TL, Huang H: Molecular evidence for an Asian origin and a unique westward migration of species in the genus Castanea via Europe to North America. Molecular Phylogenetics and Evolution 2007, 43(1):49-59.

[2]McCleary T, McAllister M, Coggeshall M, Romero-Severson J: EST-SSR markers reveal synonymies, homonymies and relationships inconsistent with putative pedigrees in chestnut cultivars. Genet Resour Crop Evol 2013, 60(4):1209-1222.

[3]Chestnut Breeding in the United States. See http://www.ct.gov/caes/cwp/view.asp?a=2823&q=376752.

Breeding Chestnuts for Nut Quality and Yield in Eastern North America: A Cooperative Breeding Program

By Greg Miller, Route 9 Cooperative, Carrollton, Ohio

Due to demand for chestnuts in the marketplace, there is a need to plant more trees. For the benefit of the growers planting trees, for the benefit of consumers, and for the benefit of the chestnut industry, the trees to be planted ought to be of the best genetic quality available. Considering all existing orchards and all existing cultivars, there is a gap between the somewhat defective quality and/or yield of current orchards and the obvious improvements available in existing newer material. Thus, chestnut orchards planted henceforth can be and ought to be genetically better than orchards currently in production. There is an opportunity to embark on a chestnut improvement program while utilizing the breeding populations as production orchards. So, I envision a cooperative chestnut improvement program funded by those planting new orchards (and ultimately production from those orchards), and directed by experienced chestnut practitioners who have identified and are familiar with the best parents available for a breeding program.

A major factor that facilitates this program is the difficulty in establishing and maintaining grafted orchards of Chinese chestnut cultivars. For reasons that are poorly understood, Chinese chestnuts suffer from delayed graft failure wherein a large portion of grafted trees die or grow poorly. For this reason, many growers have found that for commercial production, seedling orchards of Chinese chestnuts outperform grafted orchards of Chinese chestnuts. This is not the case for European, Japanese, or hybrid chestnuts. The success of seedling orchards depends on: 1) planting seedlings from good parents, and 2) planting orchards at a density that allows culling of poorer performing trees as they come into production. Generally, more than half of the seedlings from good parents will produce commercially acceptable crops. So, a culling rate of 25% to 50% will result in an orchard with genetic qualities comparable to the parents, with some individuals performing better than the parents. One irony of this program is that the need for high-quality, genetically diverse parents means that the seed for seedling orchards should come from grafted seed orchards.

Over the past few decades cultivar trials and cultivar collections have been established at many locations around the globe. It happens that the cultivars thus assembled have come from diverse genetic backgrounds. As seeds have been collected and planted from these inadvertent wide crosses, some outstanding seedlings have resulted, along with the realization that such wide crosses among good parents provide an effective way to populate seedling orchards.

The economic success of chestnut production, like most crops, is highly dependent on consistent high yields. Success is also highly dependent on nut quality; every grower knows that the number-one complaint from consumers is moldy nuts. Thus, yield and nut quality are of primary and universal importance and will be the main focus of this program. However, high yields and high quality are supported by many underlying characteristics and components, so we ultimately must consider a large number of characteristics and understand how they interact. In addition to components of yield and quality we must consider disease and pest resistance, climatic adaptation, tree growth form and vigor, etc.

Chestnuts are being grown over a wide geographic and climatic range in the USA. We are still discovering the adaptation limits of available chestnut material. Differences exist, and some are known. But we are a long way from finding and knowing what is both best adapted and best performing in the various regions. Nevertheless, major components of yield and nut quality are probably independent of regional adaptation. To wit, the material that we are starting with has demonstrated its superiority both in California and in the Midwest. It looks like this breeding program will rely mostly on plantings in eastern North America.

So, what are the defects of the material we have now? For example, some Euro-Japanese hybrids exhibit high yields, in the range of 4,000 lb/acre, but suffer from nut quality attributes like flat nut shape, thick pellicle, convoluted kernels, mealy texture, and poor keeping. Many also are blight-susceptible, phytophthora-susceptible, and not very cold hardy. On the other hand, Chinese chestnuts exist which have a desirable round shape, a thin pellicle that comes off easily, exquisite flavor, and good keeping quality, but yield in the range of 2,000 lb/acre (or less). Some Chinese chestnuts also have high blight resistance, phytophthora resistance, and cold hardiness. So, the essence of this program is to achieve the yields of the highest-yielding Euro-Japanese hybrids combined with the kernel qualities and disease/temperature tolerance of the best Chinese. Notice that the goal is to identify and combine superior attributes – regardless of which species or hybrid those traits come from. This will most likely rely on interspecific hybrids that are partially or predominantly Chinese (eastern USA bias). However, experience says that Chinese hybrids generally are not high-yielding, and the desirable Chinese characteristics are diminished, i.e., most Chinese hybrids perform worse than pure Chinese. Thus, we are seeking rare exceptions to general hybrid population characteristics. This, in turn, requires that selections be clonally propagated, or that "true breeding" seedling populations be developed (through successive generations), or that screening techniques applicable to 1-yr-old (or younger) seedlings be developed (DNA sequences?).

Nut Quality

For essentially all fruit and nut crops there is always plenty of demand, high prices, and good profits for the highest quality. For fruits and nuts, there are lots of cultural practices aimed at enhancing quality, including many practices aimed at reducing crop load. In other words, quality often trumps yield. Interestingly, there is no other produce item in supermarkets that is routinely presented in worse condition than chestnuts. Those poor-quality chestnuts are usually imported, and their poor quality is mostly due to poor handling. This situation has directly resulted in the high demand for chestnuts experienced by domestic chestnut growers. Presumably, domestic chestnut growers supply a higher-quality product. However, the low standards set by the mainstream markets and the limited supply from domestic growers allows domestic growers to get away with lower quality than will be the case in the future - when supply

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catches up with demand. And even now, every grower who sells directly to consumers knows it's a challenge and an expense to grade out bad chestnuts, to keep chestnuts in good condition, and to keep customers from complaining about quality. Quality is a major concern now; it will be even more important in the future; and nut quality must be a major part of any chestnut breeding program.

Character vs. condition. The two broad components of quality are character and condition. Character results from genetics (species, cultivar, etc.), and condition arises from environmental effects while the chestnuts are on the tree and after they come off the tree. Examples of character are nut shape and size, pellicle thickness and ease of removal, kernel texture, flavor, and color (including internal kernel breakdown). Examples of condition are weevil infestation, mechanical damage, chemical residues, mold and rots, moisture content, and sugar content. There is considerable overlap and interaction between character and condition factors. For example, nut size is greatly influenced by both genetics and the environment. Mold and rots are greatly influenced by storage and handling, but there is also tremendous genetic variation in susceptibility. Sugar content and sweetness (not exactly the same thing) are often considered to be genetic, but variation due to storage time and conditions is greater than genetic variation.

Implications and priorities for breeding. Selection for nut quality has been practiced for as long as people have been cultivating chestnuts. Nut quality was and is a main consideration for selecting cultivars, seedlings to be kept in orchards, and parents. Consequently, most of the trees in production orchards and the potential parents for breeding already have adequate nut quality characteristics. However, there still remains considerable variation within the "adequate" range, and the recent use of interspecific hybrids has expanded the variation in both good ways and bad ways (e.g., internal kernel breakdown). Part of the variation is deliberate and necessary: character needs to be different for different end uses and for different consumer preferences. On the other hand, some quality preferences are universal and economically important. The biggest problem for most growers and consumers are molds and rots; specifically, blossom end rot caused by *Colletotrichum gloeosporioides* (*Glomerella cingulata),* and postharvest spoilage caused by *Penicillium*, *Fusarium*, etc. Genetic resistance to these maladies exists and it should be a high priority in any breeding program. It is noteworthy that cultivars which exhibit high resistance to postharvest molds generally have firm-textured kernels that dry slowly (slower drying = less mold). Next in priority is ease of peeling (pellicle removal). This is important for both hand and machine peeling. Many European and Japanese cultivars are difficult to peel, while most Chinese cultivars are easy to peel (exceptions exist). Third in importance is nut shape. Round or blocky shapes, as opposed to flat or long shapes are preferred because of consumer appeal and ease of machine handling (during both harvest and processing). Beyond these three important attributes, kernels need to have adequate size, flavor, texture, and color, but the specifics depend on end use and personal preference.

In general, Chinese chestnuts seem to have the best kernel quality attributes. Almost all of them are easy-peeling, and most have a round or blocky shape. Many display good keeping qualities, but there is need for improvement in this regard. Most Chinese chestnuts are susceptible to blossom end rot. With respect to this problem, a new Chinese chestnut selection has arisen from seedlings derived from the cultivar collection at the Nanjing Botanical Garden. Named 'Liu' (in honor of Dr. Liu Liu), it was selected for its growth, yield, nut size, etc., all of which are on par with other good Chinese cultivars. Two attributes set this cultivar apart from others: 1) It has reddish colored leaves, burs and twigs, especially noticeable in the fall; and 2) It has outstanding resistance to blossom end rot and storage molds (essentially none appears). This latter characteristic elevates it to a candidate parent in this breeding program.

Yield

Mathematical chestnut yield components. Yield is an important characteristic in all crops, but it is notoriously difficult to directly select for. It is generally easier and more effective to break down yield into its components and select for the appropriate contributors. For chestnuts, yield can be broken down into several obvious components: 1) nut size (g/nut); 2) nuts/bur; 3) burs/shoot; 4) bearing shoots/land area (4a) bearing shoots/tree X; 4b) trees/land area). Yield is simply the mathematical product of these four factors. Within pure Chinese chestnuts (*Castanea mollissima*), #'s 1 and 3 are highly variable, and often inversely correlated. #2 is not so variable, and 2-3 nuts/bur are preferred. #4 is important, but complex and poorly studied/understood. Given that nut size and nuts/bur are quality characteristics that need to fall within a narrow, specified range (but different nut sizes for different markets), these characteristics can be regarded as non-variable with respect to increasing yields. Therefore, from an intuitive and readily observed standpoint, burs/shoot is a primary characteristic related to selection for yield. It is commonly observed in *C. mollissima* that when crop load exceeds about 4 burs/shoot, nut size decreases and becomes highly variable (both undesirable). So, there does seem to be a biological yield "ceiling" at which nut size and nuts/shoot compensate for each other. Furthermore, this ceiling appears to be lower for pure Chinese chestnuts than it is for some high-yielding hybrids. Simplifying, for a given tree (clone), there exists a maximum yield potential, and at or near this maximum yield, a compensatory relationship between nut size and crop load. (This is true for many tree crops.) Within Chinese chestnuts, we can genetically (and culturally) adjust the crop load to allow the desired nut size (presuming the necessary genes for nut size), but total yield is still limited by the biological yield ceiling. Since cultivated chestnuts are almost always selected to have larger nut size than their wild progenitors, there has been (perhaps inadvertently) selection for lighter crop load than is commonly found in breeding populations. In summary, it is easy to find and select individuals with high burs/shoot as a presumptive means to increase yield, but doing so decreases nut size without a substantial increase in yield. On the other hand, selection for increased nut size has coincided with selection for decreased crop load. Furthermore, decreased crop load has resulted from decreased female flower production – not decreased flower (catkin) production *per se*, but a shift in sex expression: fewer female flowers and more male flowers.

Yield ceiling. Given a desired nut size and a corresponding maximum crop load that can still achieve that nut size, the remaining way to increase yield is to raise the yield ceiling. The determinants of yield ceiling are no doubt complex, and evaluation and selection for yield ceiling are difficult to perform directly. Nevertheless, yield data from an ar-

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A Report from the 6th International Chestnut Symposium in Samsun, Turkey

by Bill Nash, Nash Nurseries and Dennis Fulbright, Michigan State University

In early October 2017, the 6th International Chestnut Symposium, sponsored by the International Society for Horticultural Science, was held in Samsun, Turkey at Ondokuz Mayis University. This international meeting follows a lineage of international meetings held every four to five years in unique chestnut-growing locations around the world, including Spoleto, Italy (1993); Bordeaux, France (1998); Chavez, Portugal (2004); Beijing, China (2008); and Shepherdstown, West Virginia (2012). In four years, the next international meeting will be held in northwest Spain.

Over 60 people attended the meeting, representing 10 different countries, including Azerbaijan, Croatia, Italy, Japan, Portugal, Romania, Slovakia, Slovenia, Turkey, and a small American contingency (3 Americans, all from Michigan). Others in attendance included students from Somalia, Bosnia, and Liberia. Attendees were mostly scientists, but also included processors, nurserymen, and growers.

It was significant that Turkey hosted this meeting, as Turkey is now the lead chestnut-producing country in Europe with 62,000 tons in production and over 30 chestnut-processing companies, not counting numerous chestnut and chestnut honey cooperatives scattered around the country.

In Turkey, chestnut is a native tree species along the Black Sea coastal mountains and can be found from the eastern border with Georgia to the western border with Romania. It is also planted in the mountains in the southern region of Turkey, not too far from the Mediterranean Sea. The tree is valued for its nuts, timber, and honey. Chestnut is not only an agricultural crop in Turkey but, as in other countries around the world, it also has a significant impact on the socio-economic and cultural life of the people.

Looking across the Bosphorous to eastern Istanbul.

Yet, as in some other chestnut-producing countries of Europe, as acreage continues to go up, yields in Turkey continue to decline. The reasons for this are not entirely known or understood, but continuing research centers on soil-borne root rots, fungal nut rots, and introduced insect pests and diseases such as chestnut blight. Some countries, like Portugal, reported hotter and drier conditions leading to horrific wild fires, and in these countries, irrigation and elixirs have become a focus.

In just 5 days we heard talks and read posters covering subjects on tree genetics and breeding, physiology, chestnut post-harvesting storage, orchard management, propagation, food processing, economics, pests and diseases, and marketing. We heard or read reports on activities in orchards and forests concerning pollination, irrigation, and pest management. We know and have learned the importance of wild trees and the biodiversity found in wild trees in Europe.

Two highlights of the meeting were visits to the Black Sea Horticultural Research Station and a trip to Nebiyan Mountain, where we observed large surviving native European chestnut trees. These large surviving trees had chestnut blight cankers but were surviving and producing nuts. It is thought that the natural biological control called hypovirulence was responsible, but research on these unique trees has not been done.

The breaks were also fascinating. Turkish coffee and tea were served along with chestnut candy. These breaks allowed for continued discussions about the data that had just been presented. The final dinner was held on a dinner boat which sailed on the Black Sea as traditional Turkish dances were performed. Attendees were also invited to learn the dances.

Overall, it was a great meeting locally hosted by our colleagues and friends Professor Umit Sedar, who worked in Dennis' lab at Michigan State University in 2011, and Graduate Research Associate Burak Akyuz, who also worked in his lab in 2016. Just a week after the meeting, Burak became a father. Congratulations! Timing is everything.

Surviving European chestnut trees on Nebiyan Mountain, Turkey.

More on Istanbul

The city of Istanbul is a very large (20 million people), clean, modern city with very old historic sections. Public transportation is modern, clean, and very efficient. It is an easy city to travel around by foot. The people were very friendly and helpful and we never felt threatened or uncomfortable during our travels.

There are dozens of beautiful and impressive mosques that dot the landscape. They are open to the public when not in use for prayer, and we visited a number of them, and they are truly architectural wonders.

There are many ancient buildings and features found in the city. The Basilica Cistern was built by the Romans in 532 and is a major tourist attraction today. It was also featured in the movie "Inferno" with Tom Hanks.

The Grand Bazaar is one of the largest and oldest covered markets in the world. With over 4,000 shops, it attracts between 250,000 to 400,000 visitors daily. It is truly fascinating to visit. If you like to bargain, then this is your place.

The Chestnut Symposium was held in the city of Samsun on the Black Sea. It was about a 7-hour drive from Istanbul through rolling countryside and scenic mountains. The country of Turkey is a beautiful country and was a real pleasure to visit. If you ever have the opportunity to visit Turkey, be sure to take it. –Dennis Fulbright

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ray of cultivars have shown that high yields are correlated with simpler, easy-to-evaluate traits. The most obvious trait associated with high yield is male sterility, exemplified by many French and Italian cultivars, the Euro-Japanese hybrid 'Colossal', and the (possibly American-Japanese) hybrid 'Luvall's Monster'. All of these cultivars exhibit a type of male sterility that is common in chestnut hybrids, expressed as the absence of stamens in otherwise normal-looking male flowers. Related to this phenomenon are reports from China that artificially emasculating Chinese chestnut shoots by removing male catkins and the male portion of bisexual catkins at an early growth stage results in substantially increased yields. Apparently, the resources devoted to pollen production effectively reduce the resources available for nut production. Thus, it appears that reducing male flower and/or pollen production can raise the nut yield ceiling. On the other hand, there are male fertile cultivars that also exhibit high yields, such as 'Szego', 'Jenny', and Jenny's mother, 'Kintzel'. These cultivars all exhibit vegetative vigor and vertically-inclined shoots. Apparently, these chestnut clones are inherently more productive (produce more photosynthate), and this extra productivity increases both vegetative growth and nut production. It is also noteworthy that these productive clones have large leaves and thick shoots, traits that are also characteristic of European chestnuts (*C. sativa*). On the other hand, highly productive Japanese chestnuts (*C. crenata*) exist which are vigorous but have thin shoots, characteristic of the species. It often happens that high-yielding cultivars are both male-sterile and vigorous, and most of the high-yielding cultivars are European hybrids. And it needs to be acknowledged that there are lots of male-sterile trees and/or vegetatively vigorous trees that do not exhibit exceptionally high yields. Thus, it appears that male sterility and vegetative vigor may **allow**, but don't necessarily **cause**, the yield ceiling to be raised.

Male sterility is genetically easy to achieve and seems to be able to contribute to higher yields. However, another approach would be to reduce male catkin production, rather than just eliminate stamen production. It could be reasoned that production of male-sterile catkins is still a waste of energy, so why not reduce or eliminate them altogether? There is genetic variation in the total number of catkins, the length of the catkins, the ratio of staminate catkins to bisexual catkins, and the number of female flowers per bisexual catkin. Presumably, yields of Chinese chestnuts could be increased if the number and/or size of staminate catkins were greatly reduced while maintaining enough bisexual catkins to produce 3-5 burs per shoot (typical number of burs on high-yielding marroni-type cultivars). The reduction in staminate catkins could be accomplished with or without accompanying male sterility. (I guess they would have to be called "astaminate male catkins" then.)

In all plants there is a partitioning of resources (photosynthate) between vegetative and reproductive growth. In most crop plants we eat the reproductive parts (fruit/seeds). Thus, crop yields have been substantially increased by genetically or culturally reducing the allocation to vegetative growth while increasing the allocation to reproductive growth. In the case of chestnuts, it would be expected that decreasing wood production would allow for increasing nut production. However, experience with chestnuts seems to run counter to this notion. Heavily fruitful cultivars such as 'Nanking' and 'Orrin' do appear to be heavy on fruit production and light on wood production, but they have not gained favor as highly productive cultivars. Likewise, efforts to reduce wood production through cultural practices (e.g., pruning, grafting) have not led to substantially higher yields. Since chestnuts are predominantly borne on vigorous, upright shoots, and this is a fundamental developmental phenomenon, it may be difficult to uncouple vegetative vigor from nut yield. However, because changing partitioning has worked in so many other crops, it remains an intriguing possibility. It will probably require a creative workaround to overcome basic chestnut biology.

Plan

One goal of this program is to create a large and genetically diverse population of individuals that "stack" an array of high-yield traits while maintaining core traits of nut quality and tree adaptation. One obvious approach would be to pollenize high-yielding male-sterile cultivars with pollen from high-yielding male-fertile cultivars. It is important also to bring in the trait of reduced catkin production. Another goal of the program is to reduce susceptibility to blossom end rot and storage mold. The ultimate goal would be to combine high yields with near-zero rots and mold. Good candidate parents exist. Following is a list, mainly suggested or affirmed by Mike Nave. All candidates have high nut quality and other top-tier characteristics.

- *'Luvall's Monster'* - vigorous growing, male-sterile, high catkin hybrid (perhaps *n*th generation *dentata* x *crenata*) from Mississippi River valley, high yielder in University of Missouri evaluations. Nuts are large, good-flavored, and easy peeling, but too wide, poor keeping and with too frequent double embryos to be used as a production cultivar outright.
- *'Ace'* - medium vigor, male-sterile, low-catkin hybrid [*C. mollissima* x (*C. crenata* x *C. sativa*) direction of crosses unknown] from Nave; above-average productivity of large nuts with high-quality, easy-peeling kernels. Nave reports that nearly all 'Ace' offspring have large nuts and low production of mostly male-sterile catkins.
- *'Szego'* - very vigorous, erect, and productive, male-fertile (heavy pollen production), from Nave. It is a complex hybrid: a seedling of the California hybrid Linden, which is predominantly *C. crenata* and *C. pumila*. The pollen parent of 'Szego' may be the Dunstan 'Revival'. It grafts well on almost anything. Nuts are uniformly large, sweet, flavorful, easy-peeling, and fairly dense, like most Chinese nuts. The nuts drop in mid-season and store very well. The tree is resistant to phytophthora root rot, and is slightly blight-susceptible.
- *'Jenny'* - vigorous, erect, male-fertile, and productive, from Nave. 'Jenny' is an open-pollinated seedling of the old Ohio cultivar 'Kintzel', which itself is a tall, vigorous *C. mollissima* (perhaps hybrid). The nuts are large and very flavorful. The nuts drop early in the season and within a very short period of time.
- *'Liu'* - medium vigor and yield, male-fertile pure *C. mollissima* seedling from Nanjing Botanical Garden (grown in Ohio by Greg Miller). It has reddish leaves, burs, and twigs and outstanding resistance to blossom end rot and storage molds. It is not yet widely propagated or progeny tested.
- *'Schlarbaum'* - average productivity, huge nuts, and very few male flowers that are mostly sterile, from Nave.
- *'Double Sweet'* – very few fertile male flowers, from Nave; a second-generation seedling of 'American Sweet', may be half 'Qing' (if not, some other *C. mollissima*).

- *'Yolo Grande'* - very few male flowers that are mostly sterile, productive, large nuts, from UC Davis; it is probably *C. mollissima* x *C. sativa*. It looks European, but the nuts are sweeter, denser, and easier-peeling than most European nuts. We don't know where it came from. Professor Serr from UC Davis picked it up somewhere (he traveled all over the world including Turkey looking for fruit and nut trees) many years ago and listed it as *C. mollissima*.
- *'Gillet'* - vigorous growing, but resulting in a compact tree; copiously male-fertile, but highly productive, from Bob Bergantz in California; probably a seedling of 'Nevada'. The tree produces huge single-embryo nuts that peel easily and store well. The nuts drop mid-season and have a good European flavor that sweetens with storage. The tree grafts well on almost anything. Offspring have been very vigorous. Probably lacks cold hardiness, blight resistance, and phytophthora resistance.
- *'Patterson'* - highly productive (especially for pure *C. mollissima*), male-fertile, squat growth habit, grown by Nave from seed collected in Nanjing Botanical Garden (provided by Liu Liu). It has large leaves and produces large sweet nuts. It appears to be morphologically different than the Chinese trees we are used to seeing in the USA.

There is no doubt that other clones ought to be on this list, especially highly productive pure *C. mollissima* other than 'Patterson'.

From the above list, the first four ('Luvall's Monster', 'Ace', 'Szego', and 'Jenny') are the only ones that are in production in the eastern USA and have a good track record there. Open-pollinated seedlings from all of them are readily available (some already in the ground) and will serve as half-sib progeny tests. (They have all been pollenized by surrounding *C. mollissima*.) Open-pollinated seedlings from the others on the list are also being planted. Pollen from 'Szego', 'Jenny', 'Patterson', and 'Liu' should be put on the male-sterile 'Luvall's Monster' and 'Ace'. Also, the "California" clones, plus 'Liu', should be grafted in the East to be further evaluated. These "special" open-pollinated progeny and controlled crosses will be incorporated into seedling production orchards, blended with "standard" seedlings from cultivars like 'Qing', 'Peach', 'Kohr', 'Gideon', 'Sleeping Giant', and others. The spacing in these seedling orchards will allow for thinning so that poor performers (25-50%) can be removed without diminishing per-acre yields. It is also recommended that seedlings from various parents be uniformly mixed in the orchards. Thus, removal of "bad" families will not create orchard gaps and retention of "good" families will not create tight clusters of trees. Based on experience with seedling orchards of "standards", the new orchards that also include "specials" should perform even better in terms of nut quality and yield for the grower. More importantly, though, performance data from both the standards and the specials will inform the breeding program and provide cultivars and/or parents for the next cycle of breeding.

All trees will be evaluated for nut quality, paying particular attention to 'Liu' offspring's storage quality. The main selection criterion for high yield will be trees that carry at least 3-5 burs per shoot that are each filled with 2-3 large, high-quality nuts. If smaller nut size is desired, shoots may be able to carry more burs. However, consistency (year to year and over the tree) of nut size and burs per shoot is of paramount importance. With the parents available, it is reasonably expected to be able to double the yield of average Chinese chestnut trees (cultivars). Hopefully, at the same time, some trees will display greatly reduced losses to rots and mold. Details of how evaluations will be performed, and who will do it, will be developed as the trees come into production.

Other Traits

This program for increasing storage quality and yield in Chinese-type chestnuts for eastern North America does not preclude evaluation and selection for other important traits such as nut size, kernel quality (flavor, special uses such as flour, etc.), weevil resistance, phytophthora resistance, dual-use trees for both timber and nut production, etc. In fact, the broad genetic base involving diverse interspecific hybrids will probably give us more variation than we see among the parents themselves.

DNA Markers

One of the advantages of chestnuts with respect to genetic improvement is that there are few barriers to making and using interspecific hybrids. In other words, we have a giant gene pool consisting of the whole genus *Castanea* to draw genes and gene blocks from. And one of the disadvantages of chestnuts with respect to genetic improvement is that we have such an overwhelmingly large gene pool to deal with. We have a giant gene pool to sort through. This program is relying heavily on a few outstanding interspecific hybrids, plus some individuals that are "pure" *C. mollissima*. Mostly, we don't know the ancestry of the chosen parents. It is noteworthy that, in general, most hybrid chestnuts are maladapted and would make poor production orchards. We don't yet know how the offspring of our selected parents will perform. Some will probably be outstanding; some will probably be complete duds. How many in each category? Who knows. We're playing a sort of genetic card game: parents are the "decks"; offspring are the "hands". If we play the game long enough we can eventually find out which decks give us the best hands, and then which hands make the best decks. This laborious process would go much faster and more efficiently if the cards were marked. It turns out that there is a way to "mark" the cards, or more precisely, read the marks that are already there. Within chestnuts there are hundreds of known DNA markers that vary across species and within species. Already underway is a project in Dr. Jeanne Romero-Severson's lab to identify a set of DNA markers that will allow us to ascertain the parents and grandparents of a given tree as well as quantify and qualify the species mix (see page 1). This marker set is called an Ancestry Informative Marker Set (AIMS), and such marker sets have proven valuable in breeding other crops. It will allow us to keep track of parents and offspring in the breeding program and indicate good parental combinations to try.

At the time of this writing, there are 29 growers across 15 states who have planted over 12,000 chestnut seedlings from 23 different mother trees and 3 special populations over the past 3 years. The plantings will serve as commercial orchards, as progeny tests for the various families, and as trials for new cultivars. In the future, thousands more seedlings will be planted as part of this cooperative breeding program. Thus, large numbers of seedlings from diverse and elite parents are being tested over a wide range of environments. Growers know what they are looking for and can recognize superior seedlings better than academic breeders. As these trees come into bearing, record keeping, evaluation, and sharing of information will need to be coordinated. Such extensive data analysis and utilization of DNA markers will likely involve academic researchers.

For Sale / Seeking

CGA members can post equipment or other items they want to buy or have for sale, free. Send your submissions to chestnutgrowersofamerica@gmail.com.

SEEKING: Scion wood of Bergantz chestnut. Exchange possible. Contact: Davor Juretic, juretic.davor@gmail.com.

FOR SALE: Comm Chestnut Orchard + Home. N. Calif. Klamath River frontage. Appx. 800 Trees Colossal/Nevada. Trees are 20+ years old. Modern home 3+2; appx 2000 Sq. Ft. Off Grid - Solar Power; 55 Acres Total. Viewable on Goodle Earth. Website: rockybarchestnuts.com. Link to Flicker for additional photos. Seller carry; $595,000. Email: Dhenn@dantel.com; Tel: (352) 633-6185.

FOR SALE: Chestnut Orchard, 71 Dunstan hybrid trees planted in 1994 on 1.1 lake front acres - beautiful home site, located in Dyer County, Tennessee. For additional information call Joe Welborn (901) 828-7957.

FOR SALE: See photos at right. (1) Kubota 35hp 4x4 with loader. Has bucket and forks, turf tires, and shows approximately 860hrs on meter. (2) Facma trailed harvester in great shape. Extra hoses for one or two-person setup. (3) Flory orchard sweeper. New rubber fingers on head. Machine good and straight. Will sell as a package or separate. Contact Devon Milligan at (706) 681-1542.

Chestnut Growers of America End-of year Financial Report, 2015-2017

		2017	2016	2015
Income				
	Annual Meeting Registrations	4,486.59	3,290.00	1,815.00
	Annual Meeting Silent Auction	282.00	1,039.00	--
	Membership Dues	4,595.65	3,475.00	2,945.00
	Online Grower Directory	125.00	0.00	325.00
	Interest Income	66.73	54.72	6.42
	Newsletter Advertising	133.68	25.00	80.00
Total Income		**9,689.65**	**7,883.72**	**5,171.42**
Expenses				
	DNA Study – AIMS Project	(10,000.00)	--	--
	Annual Meeting	(3,740.93)	(1,117.97)	(885.67)
	Directory	--	(196.54)	(177.31)
	Insurance	(1,032.25)	(1,032.25)	(1,032.25)
	Newsletter	(916.06)	(424.98)	(587.34)
	Communications Director	(3,332.07)	(2,626.92)	(0.00)
	Organizational Expenses	--	(100.87)	(114.97)
	Website	(226.90)	(236.92)	(412.32)
	Dues Collection Expenses	--	(0.00)	(109.98)
	Bank Charges	--	(12.78)	(10.70)
Total Expenses		**(19,248.21)**	**(5,749.23)**	**(3,330.54)**
Net Income		***(9,558.56)***	***2,134.49***	***1,840.88***
Cash, beginning of year		***33,344.38***	***31,367.89***	***29,527.01***
Cash, end of year		***23,785.82***	***33,344.38***	***31,367.89***

Membership Report, 2016-2017

Members	**2017**	**2016**
Household	61	56
Individual	46	47
Associate	1	2
Honorary	0	1
Complimentary	3	4
Total	111	110

Summaries prepared by Jack Kirk, CGA secretary / treasurer.

Renew Your CGA Membership for 2018

Please complete the enclosed form to renew your CGA membership for 2018. Alternatively, you can download a fillable PDF from the CGA website and pay your dues online via PayPal (see instructions at top of form). Thank you!

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Quality Chestnut Trees from a Reliable Source!

Washington Chestnut Company has become an industry leader in the propagation of chestnut trees. The chestnut trees we offer are grown in the Pacific Northwest, free of exposure to chestnut blight and gall wasps.

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Maraval
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Marigoule
Marrisard
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Bisalta #3
Belle Epine
Gillet
Szego
Regis Montis
Regina Montis
Marrone di Comballe
Marrone di Marradi
Pure American Chestnut
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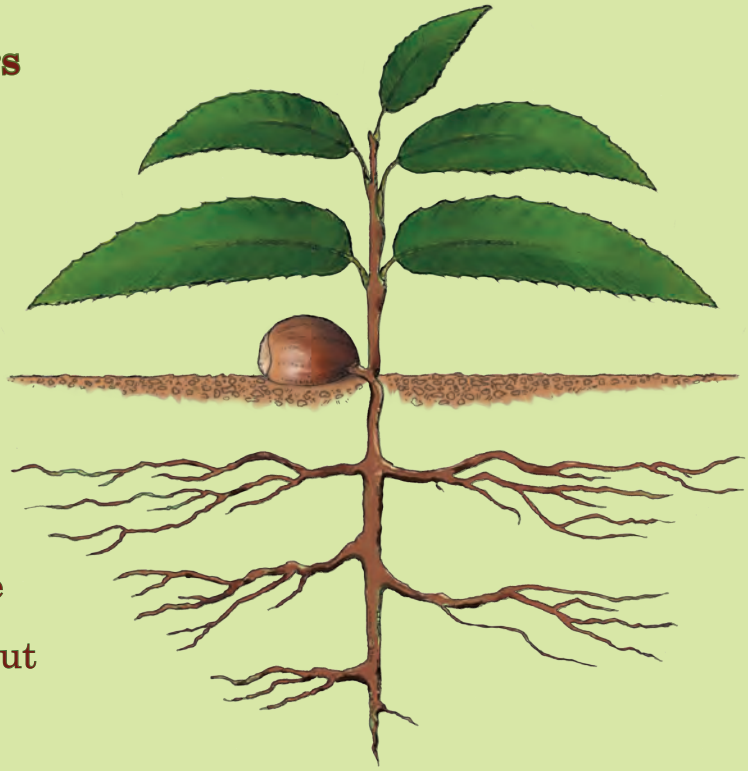

Our web site has full descriptions of each cultivar
and lots of help with growing chestnut trees.

www.WashingtonChestnut.com

Washingon Chestnut Company
6160 Everson Goshen Rd., Everson, WA 98247
Phone (360) 966-7158

Chestnut Growers of America
16 Pond Road
Deering, NH 03244

The Chestnut Grower

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