A Progeny Selection Program From Superior Parentage Chestnuts in the Pacific Northwest

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ABSTRACT. *Castanea* germplasm is not native to the West Coast of North America, but originally was introduced from Europe, Asia and the eastern United States by several plant breeders during the 19th century. Evaluations of the existing population of chestnut trees throughout the West Coast area is currently underway so that superior nut and timber producing parents can be identified for use in breeding programs. As a result of this project, six new selections from the existing population of chestnut trees in the Pacific Northwest have been identified and named. Progeny from these select mother trees are being evaluated for traits that could be used to select new, locally adapted cultivars for the continued development and enhancement of the West Coast chestnut industry.

Anyone visiting in the Pacific Northwest becomes immediately aware of the predominance of conifer tree species. Hardwood species, such as alders, in the past have been viewed as "trash" trees, interrupting otherwise uniform stands of Douglas-fir. Yet hardwoods can, and do thrive within the Northwest biosystem, and plantings of such can be as commercially viable as "traditional" timber crops west of the Cascades.

In the interest of diversification, hardwood species, such as chestnut, are being reintroduced. A tree producing a nut crop for many years on its way to a harvestable sawlog, offers the advantage of potential income until maturation, that the conifer species usually do not. It should be emphasized that the chestnut species is a reintroduction in the Pacific Northwest, for not only did the early settlers import and plant them, but the fossil record shows evidence of *Castanea* spp. existing in the Northwest before the rise of the Cascade Range (6, 15, 18).

Chestnut represents an extremely viable addition to the conifer monoculture, as well as a competitive complement to the hardwood species inventory. They can be profitable for the multi-purpose timber orchardist and beneficial to wildlife during their maturation into a productive hardwood timber crop.

HISTORY OF CHESTNUT INTRODUCTIONS ON THE WEST COAST

Extant *Castanea* germplasm was initially introduced from Europe, Asia and the eastern United States by southern European settlers and prominent horticulturalists. The earliest introductions on the West Coast have been traced to the latter half of the 19th century around the time of the great California gold rush (9, 10, 17, 20, 21, 23). While fruit and nut growing officially got its start around 1847 in the Pacific Northwest (14), it wasn't until, perhaps the 1870's, that chestnuts were introduced into Oregon (9). The earliest record of chestnut breeding in British Columbia, Canada, began somewhere around the late 1920's and early 1930's with J.U. Gellatly.

Commercial chestnut orchards on the West Coast peaked during the late 1930's with the onset of chestnut blight in the eastern United States (21). Unfortunately, with the competition of low-priced import nuts from Europe, the profitability for California nuts shipped to the Fast Coast failed within the following few decades. At this time, most of California's original orchards were removed, although chestnut orcharding is now experiencing a comeback with the onset of increased plantings throughout the West Coast.

Castanea sativa Mill. was probably the first species of chestnut to be introduced to the West Coast, generally as small ranch house plantings of two to three trees throughout the fruit production areas of California. Felix Gillette came from France in the 1850's to Nevada City, Calif. (14). He was one of the first and most influential chestnut industry pioneers on the west coast due to his extensive introductions and an early specialty of propagating a large collection of French marrone varieties at his Barren Hills Nursery as early as 1880 (21). After his death, C.E. Par-

sons took over as proprietor of the Barren Hills Nursery and made several selections in the early 1920's from existing collections including, 'Large American Sweet' and `Colossal'(3).

C. crenata Sieb. and Zucc. was well established during the 1880's, and may have been the first species in California to be planted commercially (21). Primary establishment was done extensively as seedling orchards. Market speculation was based on the large size, high yield and the precociousness of a few superior Japanese seedlings and grafted trees imported in the eastern U.S. by nurserymen such as S.B. Parsons of Flushing, N.Y. and William Parry of N.J. The initial success of these select Japanese seedlings on the Fast Coast resulted in hundreds of seedling *C. crenata* trees being planted in the west by California fruit growers and nurserymen. These trees were distributed as "Japan Chestnut" from seed imported into California direct from the Orient (10). Luther Burbank of Santa Rosa, Calif. worked extensively with seed of *C. crenata,* as well as *C. sativa* and *C. dentata* (Marsh.) Borkh., which he imported in 1884 (4). He eventually released several named varieties.

Apparently, *C. dentata* also was being introduced on the West Coast during this same period as is evidenced by offerings of seedlings in early nursery catalogs of the California Nursery Company of Niles, Calif. (21). It wasn't until 40-50 yr later that improved varieties of the American chestnut originating on the West Coast were offered, with credit going to Al. Wiske of Grass Valley for their introduction (23). Albert Etter of Ettersburg, Calif., began a chestnut breeding program around 1900, with the main objective of developing a timber-type American chestnut with a fruit that was sweet, easily peeled and with the large size of the Japanese and European nuts (M. Etter, personal communication). He incorporated cultivars of *C. sativa* and *C. crenata* into his breeding program and worked extensively with the 'Large American Sweet' strain of *C. dentata* acquired from his colleagues at the California Nursery Company (M. Etter, personal communication).

The earliest recorded introduction of C. *mollissima* Bl. to the West Coast is credited to J.H. Reisner in 1926 through the auspices of the USDA Plant Introduction Station in Chico, Calif. Two hundred trees were planted from this introduction that originated as seed from Nanking, China. Two selections from this planting were subsequently released by the USDA for further testing after evaluation between 1935-45 by Milo N. Wood (21). There also are reports of others working with germplasm from this planting (5).

Carroll D. Bush of Eagle Creek, Ore. worked extensively with the Chinese chestnut, utilizing seed he imported from central China (5). The variety 'Abundance,' selected in 1941, was one of his most notable selections (3). Bush makes a strong case for new plantings of disease-resistant Chinese chestnuts, although this species is presently found quite rarely on the west coast. During the 1920's, J.U. Gellatly of West Bank, British Columbia, in the Okanogan Valley of Canada, hand-selected Chinese chestnut seed from a large commercial import shipment and developed several named cultivars of open pollinated seedlings (12, 13). `Layeroka,' is a seedling from one of these named variety, open-pollinated, Chinese seedlings and is currently the most widely planted grafted chestnut variety in North America.

Even after virtual abandonment for several decades, the survival of chestnut attests to the fact that this tree is well adapted to cultivation in the West Coast region of the United States. Currently, there are scattered remnants of the original chestnut trees from the introductory phase of plantings on the West Coast. These chestnut trees are commonly found throughout the Pacific Northwest in small groupings. They average about 60-80 yr of age, with trunks averaging 1 m d.b.h. Record size chestnut trees exist in the Pacific Northwest, including the world's largest *C. dentata,* and the nations's largest *C. sativa,* both of which are found in western Washington (23). Chestnut trees have, in several cases, escaped from original homestead boundaries and have naturalized in the surrounding forests, competing well with the native hardwood and coniferous species.

PHASE I. SELECTION OF SUPERIOR PARENTAL STOCK

Surveys of the existing population of chestnut trees in the Pacific Northwest began in 1985. A progeny selection program is in progress to evaluate the possibility of finding superior germplasm from the early West Coast introductions. With the increasing realization that chestnut orcharding could become a viable nut and timber industry, the development of regional cultivars becomes of primary importance. The criteria used to evaluate a progenitor tree for potential use in a commercial orchard or breeding program is based primarily on the quality of the nut it produces and its recent record of nut production in this area. Nut characteristics have been evaluated over as long a period as possible to confirm reliable and consistent results. Cultivars that have been described in this report have a minimum of six years of data and will be evaluated continually. The long-term goal of this project is to help identify and increase the numbers of superior chestnut varieties that eventually can be used to create successful commercial nut and/or timber producing orchards for the Pacific Northwest.

Nut-producing chestnut cultivars must be climatically suited to the marine, inland and mountain communities where they could be grown. Early ripening, good size and flavor are important selection criteria to consider in order for nut crops to compete successfully with the imported chestnuts already on the market. Strong selection emphasis is placed on the flavor and peeling characteristics of the inner skin, or pellicle of the nut meat. Ideally, kernels should not contain multi-embryos and minimally should be convoluted so that its pellicle doesn't fold throughout the meat. Nut selections are limited to, at most, 30 nuts/lb (66/kg). The color of the nut shell is a

consideration to a lesser extent, as attractive, light reddish coloring and/or distinct striping enhance marketability.

Pollination has a direct effect on the properties of the nut a chestnut tree will produce from season-to-season, as well as with nuts produced during the current season (7, 11, 16). The effect of pollen on fruit set is known as xenia. For this reason, consideration of pollinators becomes crucial to the establishment of nut producing chestnut orchards with limited varietal pollen sources. Pollinators have been identified for this project in order to facilitate the production of consistent predictable quality chestnuts in grafted progenitor cultivar orchards.

Timber value is the other major consideration in the selection of superior parental stock. As a timber tree for the Northwest, chestnut offers many advantages (2). The wood is highly resistant to rot and 20-yr-old interplant thinnings can be coppiced continually for poles that can be used in fence and trellis applications. As the bole matures on the unthinned trees, high quality hardwood lumber can be harvested in 40-60 yr cycles and milled for a variety of uses including construction, furniture and veneer. An important reforestation advantage of chestnut is that once planted, a chestnut timberlot does not require replantation following harvest. An initial chestnut timber planting can be harvested continually on 60-100 yr rotations for several centuries without replanting, due to the tree's ability to resprout from cut stumps. This can translate into a savings of time, energy and expense with site preparation and replant needs required of other timber species.

Evaluations of timber progenitor cultivars at this time are based primarily on tree form and vigor, as the majority of *C. sativa* species are useful for sawlog production if cultural techniques are optimized for this purpose. Timber characteristics, such as color and radial checking have not been considered yet, due to practical limitations. Adaptability to local climates and the potential for resistance to disease and insect problems may be a factor that is optimized by utilizing well-established, clear-boled parental stock that exhibits healthy and vigorous growth. Timber selections that also serve as nut producers may influence the potential of using Northwest cultivars for both nut and timber production.

NEW PACIFIC NORTHWEST REGIONAL CHESTNUT PROGENITOR CULTIVAR DESCRIPTIONS

The following is a brief description of carefully selected parent trees that have been identified and now formally named as new cultivars to use as seed sources for the development of dual purpose varieties adapted for the West Coast states. From the hundreds of trees that have been observed throughout the Pacific Northwest, only a select few meet the criteria necessary for breeding stock. The search for chestnut trees that meet these requirements is an ongoing process.

The criteria used in selection of superior seed parents are based on the following: a) reliable annual production of consistent, commercial quality in-shell nuts; b) adaptation to local climates; c) vigorous growth, with an inherent degree of resistance to diseases and insect problems; and, d) useful timber form.

1.`Madeline'—This tree is a *C. sativa* or possibly a *C. sativa* x *C. crenata* hybrid in a 20-yr-old planting with other European and Chinese chestnuts. The tree is pyramidal in shape. Some degree of blight resistance in its offspring are expected due to the presence of *C. mollissima* pollen within the orchard planting. The nut is one of the largest in this collection, averaging 20-21 nuts/lb (44-46/kg), with 1-2 nuts per burr. The kernal is spherical shaped, peels well and has a sweet flavor. The outer shell is red with brown stripes and is very beautiful; hylum is square shaped with a slight tendency towards shell splitting, and it ripens in mid-season. Isoperoxidase enzyme type A-

2.`Canby'—This is a large, 1-m diameter, *C. sativa* tree planted about 70-100 yr ago. It has timber form and its nuts average around 35/1b (77/kg); the tree produces over 300 lb of nuts annually. The kernal is elliptical, very sweet and peels exceptionally well, suitable for fresh roasting or drying. It produces a shiny brown nut that ripens in mid-season. Isoperoxidase enzyme type AB.

3. `Sailor'—A large, timber form *C. sativa* from an 80-yr-old plantation of chestnuts that are naturalizing onto the hillsides above the Siusilaw River in a small valley on the western Coast Range. The tree produces a sweet tasting nut that ripens mid-to-late season, with a light brown-colored shell and dark striping. The large kernal, averages 20-22 nuts/lb (44-48/kg) and is elliptical shaped. Pellicle peels well and less than 3% of the nuts are multi-embryoed. Isoperoxidase enzyme type AB.

4.'Holiday King'—This is a large timber-form *C. sativa* that was planted during the early 1900's. The tree was selected for fresh nut market. The nut has an excellent flavor, is light-colored and brightly striped, and averages 31 nuts/lb (68/kg); it is early ripening with one nut per burr. The kernal is spherical shaped and peels exceptionally well. Isoperoxidase enzyme type unknown.

5.'St. Helen's'—This is a 3.5-m diameter *C. sativa* with a 19-m spread and a thick-trunked timber habit. Nut size is 30-32/1b (66-70/kg) and is dark chocolate brown in color. This tree was selected for use as parental stock due to nut flavor, peelability and productivity. The nuts are sweet and peel exceptionally well. This tree consistently yields over 350 lbs annually. The kernal is elliptical shaped and the burrs contain two-to-three nuts per burr. Isoperoxidase enzyme type A.

'Loyal'— This *C. sativa* selection from the same planting as 'Sailor,' from the Siusilaw River. It has excellent timber habit. The nut size averages 22/1b (48/kg). The shells are shiny brown in color and the kernal is elliptical shaped, peels well and is sweet tasting; less than 10% are multi-embryoed. The nut ripens in mid-season. Isoperoxidase enzyme type unknown.

PHASE II. SELECTION OF SUPERIOR PROGENY

Seedlings of the above selection will be grown to several years of fruition in order to determine their value as a nut producer and evaluate their potential timber habit. It is important that outplantings be made in as many locations as possible in order to increase the project's database and evaluate regional adaptability. Test plantings of these seedlings already have been established at several locations, although no plots have come into production as of this date. Outplanting sites currently are being established through the dissemination of nursery stock.

It is expected that some of the characteristics of the selected parental varieties will be expressed by their offspring. The challenge then is to plant enough seedlings to allow for the expression of the better traits. Once superior progeny have been identified, they will be open pollinated to enhance further the possibility of seedling improvement.

Due to the large numbers of seedlings needed for the expression of traits that are desirable, it is necessary to develop a viable strategy for outplanting. Timber plantings become most advantageous as large numbers of trees can be planted per acre. Seedling plantings, primarily for nut production have been encouraged to a limited extent, with the idea of topworking to improve the nut quality of inferior seedlings. Graft incompatibility can be minimized through rigorous labelling of individual seedling varieties and cambial typing (1, 20, 21).

CONCLUSIONS

The selection of chestnut cultivars with ideal traits for timber and nut orcharding chestnuts in the Pacific Northwest needs to address all known limitations of growing and marketing the potential crop. In addition to the quality of the nuts and timber, this includes selecting and developing resistance to diseases and insects such as the chestnut blight fungus, *Cryphonectria parasitica* (Murr. Barr); root rot fungi, *Phytophthora* spp.; and, gall wasp, *Dryocosmus kuriphilus* Yasumatsu.

The scope of this project cannot practically address resistance to disease and pests that are currently not a threat in this area, although the intent is not to underestimate their potential damage to damage an established or fledgling chestnut industry. Utilizing superior existing individual trees, already well-established in the Pacific Northwest, provides the base point for further breeding work with other cultivars that possess known resistance. Parallel to this project is the introduction of select cultivars that incorporate new traits that currently may not exist within the Pacific Northwest germplasm pool. Such introductions already have been initiated (8), and evaluation of their regional adaptability will be made as they come into production.

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