Recent Introduction of European Chestnut Varieties into the USA

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ABSTRACT. Growth of a chestnut industry in North America has been slowed, in part, by the unavailability of superior cultivars, such as the famous 'Marrone' types, grown extensively in Europe. Introductions into the USA were made of the best clones currently available in Europe. Selections were drawn primarily from the variety collections of the Piemonte Asprofrut Association of Piedmontese Fruit Growers. Graft incompatibility may involve cambial peroxidase isozymes, and samples of each scion were sent to Frank S. Santamour, Jr. of the U.S. National Arboretum in Washington, D.C. for isozyme typing. Grafting onto isozyme typed seedling rootstocks was accomplished at the nursery of Mr. Michael Dolan of Onalaska, Wash. This introduction represents the largest single introduction of European varieties into the USA in recent history, and includes some of the best cultivars known. These cultivars should contribute significantly to the developing chestnut industry in the USA.

The growth of the North American chestnut industry has been slowed, in part, by the unavailability of superior cultivars (1, 4). As a new crop for the United States, chestnut has the potential to offer significant economic returns requiring minimal inputs (3, 12).

The scope of the present work was twofold, to characterize the famous 'Marrone' types and the best of the European and Euro-Japanese hybrid chestnut clones currently available in Europe on the basis of their cambial isoperoxidase phenotypes, and to introduce these cultivars into the USA.

MATERIALS AND METHODS

Introductions into the USA were made in the early spring of 1989 and again in 1991 using material drawn primarily from the cultivar collections of the Asprofrut Association of Piedmontese Fruit Growers, at Spinetta and Boves in the Province of Cuneo, Italy. Local Piemontese cultivars were collected in the traditional "castagneti da frutto," the ancient chestnut groves typical of the Piedmont Region. Dormant scionwood was cut from clones of European *(Castanea sativa* Mill.), Japanese *(C. crenata* Sieb. & Zucc.) and Euro-Japanese hybrid chestnuts. Scions were rinsed in a weak solution of sodium hypoclorite, then soaked for 1 h in a 1.5 g/1 benomyl solution and shipped under the USDA—APHIS quarantine label. The port of entry and inspection was Seattle, Wash. Samples of each scion type were sent to Frank S. Santamour, Jr. of the U.S. National Arboretum in Washington, D.C. for isozyme typing. Grafting onto isozyme-typed seedling rootstocks was accomplished at the nursery of Michael Dolan of Onalaska, Wash. Three on-site inspections were made by the USDA during the first growing season. The material will be held in post-entry quarantine for two years and then made available to researchers and nurseries.

RESULTS

Introduced varieties are reported in Table 1 with country of origin, species and cambial isoperoxidase band patterns. Figure 1 shows the approximate geographical origins of the European cultivars.

Table 1. Cultivar name, species composition, country of origin and peroxidase enzyme banding pattern of chestnut cultivars introduced into USA.

Cultivar	Species*	Country of Origin	Peroxidase Band**
Belle Epine	S	France	B
Bisalta 2	S × C	Italy	AB
Bisalta 3	S × C	Italy	AB
Bouche Rouge	S	France	B
Bouche de Bétizac	S × C	France	B
Bournette	C × S	France	B
Bracalla	S	Italy	AB
Cardaccio	S	Italy	–
Castagna della Madonna	S	Italy	B
Garrone Rosso	S	Italy	AB
Ginyose	C	Japan	B
Givigliasca	S	Italy	AB
HL	S	Spain	AB
HS	S	Spain	AB
Ipharra	C	Japan	B
Ishizuki	C	Japan	B
Lusenta	C × S	Italy	AB
Maraval	C × S	France	AB
Marigoule	C × S	France	AB
Marlhac	S × C	France	AB
Marissard	S × C	France	AB
Marki	C	France	B
Marron Comballe	S	France	B
Marron du Var	S	France	A
Marron d'Olargues	S	France	B
Marrone Fiorentino	S	Italy	AB
Marrone di Borgovelino	S	Italy	B
Marrone di Castel del Rio	S	Italy	B
Marrone di Chiusa Pesio	S	Italy	AB
Marrone di Città di Castello	S	Italy	B
Marrone di Luserna	S	Italy	B
Marrone di Marradi	S	Italy	B
Marrone di Montemarano	S	Italy	AB
Marrone di Roccadaspide	S	Italy	AB
Marrone di S. Mauro Saline	S	Italy	–
Marrone di Val di Susa	S	Italy	B
Marrone di Verona	S	Italy	B
Marrone di Villar Pellice	S	Italy	B
Marrone di Viterbo	S	Italy	–
Marsol	C × S	France	AB
Mozza	S	Italy	–
Neirana di Villar Pellice	S	Italy	AB
Pelosa Grossa	S	Italy	AB
Pelosa Piccola	S	Italy	AB
Précoce Migoule	C × S	France	AB
Primato	C × S	Italy	AB
Ruiana	S	Italy	AB
Solenga	S	Italy	AB
TO 613	C × S	Italy	AB
Tanzawa	C	Japan	B
Tempestiva	S	Italy	–
Tsukuba	C	Japan	B
Vignols	C × S	France	AB

*S = *Castanea sativa*; C = *Castanea crenata*

**Band = cambial isoperoxidase banding pattern

Only two of the peroxidase bands (A and B) were seen. The European *C. sativa* cultivars had either band B or both A and B with the exception of Marron du Var, which was the only cultivar with only band A. All cultivars of *C. crenata* had only band B while most of the hybrids had both A and B bands. The cultivars Bournette and Bouche de Bétizac are the only Euro-Japanese hybrids not having cambial isoperoxidase band pattern AB.

DISCUSSION

This introduction represents the largest single introduction of chestnut germplasm into the USA in recent history, and includes some of the best varieties known, and should contribute significantly to the growing chestnut industry there.

The cambial peroxidase enzymes, responsible for the processes of lignin polymerization and the bonding of

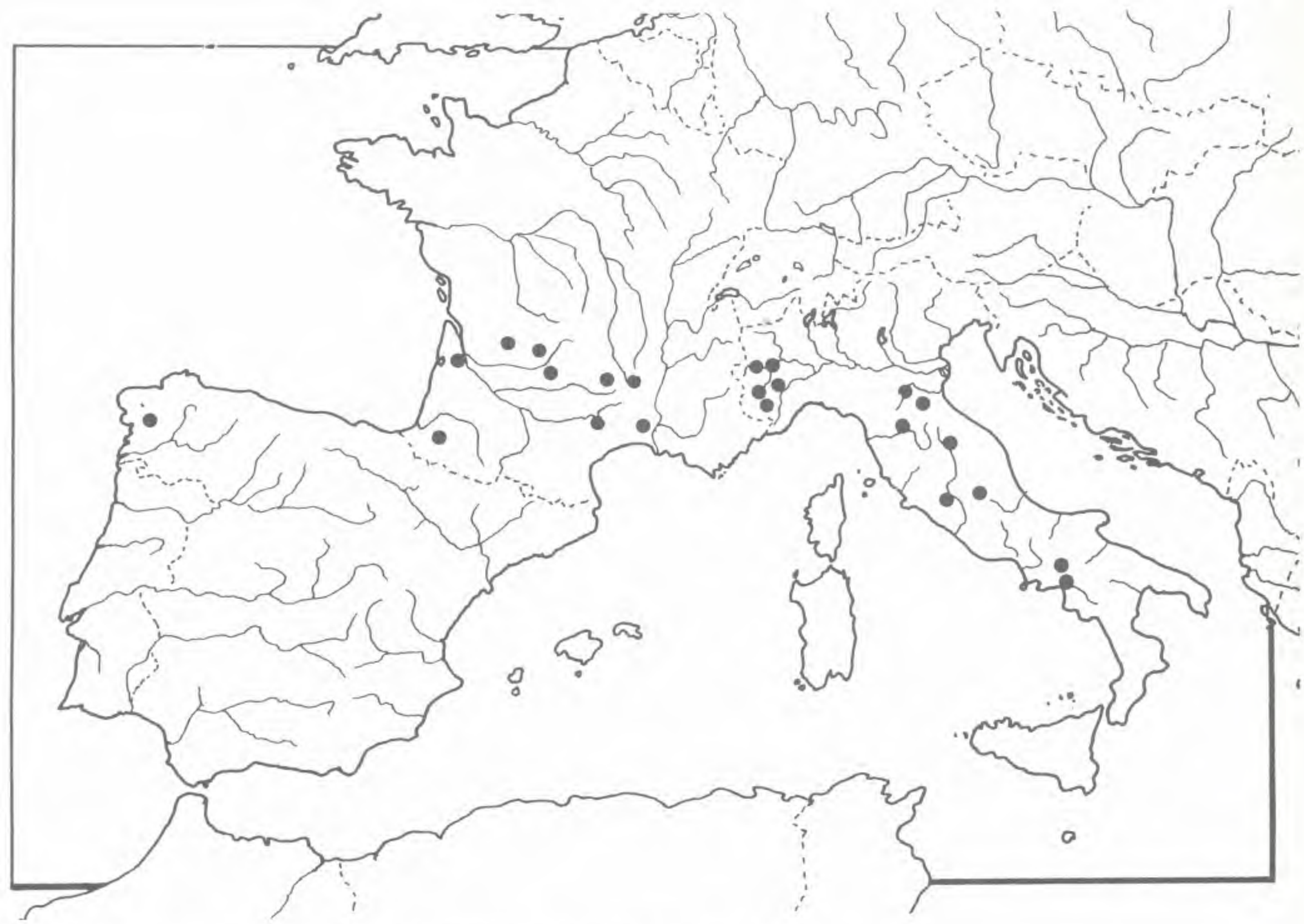

Figure 1. Approximate geographic origins of the chestnut cultivars introduced into the USA.

lignin to the carbohydrates of the primary cell wall, have been indicated as having a determining role in the successful formation of graft unions (9). There are four known isozyme groups in *Castanea* spp., typed A, B, AB and BC depending on the presence of the various enzyme bands as visualized by isoenzyme electrophoresis (2, 11).

Dissimilarity of peroxidase type may result in failure of establishment of vascular continuity between rootstock and scion due to abnormal lignification. Santamour (10) has shown in reciprocal grafting experiments with C. *mollissima,* when the isozyme phenotype of scion matched that of the rootstock, a complete graft union was formed with vascular xylem continuity. However, when the isozyme phenotype of the scion differed from that of the stock, vascular continuity was not observed and the grafts often failed.

Graft incompatibility has not been a problem historically in Europe where clones of the single species C. *sativa* traditionally have been grafted onto seedlings of the same or similar clones. Fineschi et al. *(5)* have shown high conservatism in chestnut isozyme phenotype variability among cultivated forms within geographic regions, and Villani et al. (13) have shown very high isozyme homogeneity for all `Marroni' examined. General recommendations for grafting onto seedlings of the same clone as the scion have been based on the empirical notion that these grafts often survived, yet in some cases, especially among interspecific hybrids, graft incompatibility has been seen (6).

Graft failure and delayed graft incompatibility are commonly reported, in the USA, as being major limiting factors in vegetative propagation of chestnut not only at the interspecific and hybrid level, but also in intraspecific grafts with clones of *C. mollissima (7,* 8, 14).

However, with the recent introductions of exotic germplasm and new hybrids, graft incompatibility has begun to appear in Europe as well. Figure 2 shows an example of delayed graft incompatibility in a *C. crenata* x C. *saliva* clone grafted onto seedling *C. crenata* rootstock. Note the clean break at the graft union indicative of complete lack of vascular continuity.

Knowledge of the isozyme types may facilitate diffusion of the introduced varieties in the USA and will allow the nursery industry to avoid costly failures due to incompatible scion/stock combinations. A possible application might include the use of *Phytophthora* spp. resistant, isozyme-typed interspecific hybrid rootstocks for the propagation of `Marroni.'

Figure 2. Delayed graft incompatibility in Euro-Japanese hybrid chestnut grafted onto seedling Japanese rootstock.

LITERATURE CITED

1. Anagnostakis, S.L. 1989. An historical reference for chestnut introductions into North America. Ann. Rep. North. Nut Growers Assoc. 80:132-143.
2. Anagnostakis, S.L. 1991. Peroxidase allozyme phenotypes in *Castanea* and their segregation among progeny. HortScience 26:14-24.
3. Burnett, M.S. 1987. The potential for a chestnut industry in the United States. Pages 2-4 in: Chestnuts and Creating a Commercial Chestnut Industry: Proceedings of the Second Pacific Northwest Chestnut Congress, August 22-23, Corvallis, Ore. M.S. Burnett and R.D. Wallace, eds. Chestnut Growers Exchange, Portland, Ore, USA. 122 pp.
4. Craddock, J.H., Romisondo, P., Pellegrino, S. and Bassi, G. 1990. Chestnut germplasm introduction into USA. Abstract 4004 in: Abstracts of Contributed Papers. 2. Poster. XXIII International Horticultural Congress, Firenze, Italy, 27 August-1 September 1990.
5. Fineschi, S., Malvolti, M.E., Morgante, M., Vendramin, G.G. and Pacciucci, M. 1990. Genetic studies on cultivated chestnut. Abstract 1284 in: Abstracts of Contributed Papers. 1. Oral. XXIII International Horticultural Congress, Firenze, Italy, 27 August-1 September 1990.
6. Jaynes, R.A. 1979. Chestnuts. Pages 111-127 in: Nut tree culture in North America. R.A. Jaynes, ed. Northern Nut Growers Association, Hamden, Conn. 466 pp.
7. Lagerstedt, H.B. 1987. A review of chestnut propagation. Pages 56-61 in: Chestnuts and Creating a Commercial Chestnut Industry: Proceedings of the Second Pacific Northwest Chestnut Congress, August 22-23,1987. M.S. Burnett and R.D. Wallace, eds. Corvallis, Ore. Chestnut Growers Exchange, Portland, Ore. 122 pp.

8. McKay, J.W. 1947. Results of a Chinese chestnut rootstock experiment. Ann. Rep. North. Nut Growers Assoc. 38:83-85.
9. Santamour, F.S., Jr. 1988. Graft incompatibility in woody plants: an expanded perspective. J. Environ. Hort. 6:27-32.
10. Santamour, F.S., Jr. 1988. Graft incompatibility related to cambial peroxidase isozymes in chinese chestnut. J. Environ. Hort. 6:33-39.
11. Santamour, F.S., Jr., McArdle, A.J. and Jaynes, R.A. 1986. Cambial isoperoxidase patterns in *Castanea*. J. Environ. Hort. 4:14-16.
12. Smith, J.R. 1950. Tree crops—a permanent agriculture. Devin-Adair Co., New York, N.Y. (First edition, 1929). 408 pp.
13. Villani, F., Malvolti, M.E., Bimbi, R. and Paciucci, M. 1986. Analisi elettroforetica per lo studio della genetics del castagno: aspetti metodologici e applicativi. Pages 71-75 in: Giornate di studio sul castagno. Caprarola (Viterbo) 6-7 November 1986. Comunia Montana dei Cimini, Caprarola, (VT), Italy. 365 pp.
14. Weber, G.C. and MacDaniels, L.H. 1969. Propagation. Pages 18-38 in: Handbook of North American Nut Trees. R.A. Jaynes, ed. Northern Nut Growers Association, Hamden, Conn.