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Genetic Relationship of Ornamental Peach Determined Using AFLP Markers

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Abstract. **Ornamental peach (*Prunus persica* (L.) Batsch) is a popular plant for urban landscapes and gardens. However, the genetic relationship among ornamental peach cultivars is unclear. In this report, a group of 51 ornamental peach taxa, originated from *P. persica* and *P. davidiana* (Carr.) Franch., has been studied using AFLPs. The samples were collected from China, Japan, and US. A total of 275 useful markers ranging in size from 75 to 500 base pairs were generated using six EcoRI/MseI AFLP primer pairs. Among them, 265 bands were polymorphic. Total markers for each taxon ranged from 90 to 140 with an average of 120. Two clades were apparent on the PAUP–UPGMA tree with *P. davidiana* forming an outgroup to *P. persica*, indicates that *P. davidiana* contributed less to the ornamental peach gene pools. Within *P. persica* clade, 18 out of 20 upright ornamental peach cultivars formed a clade, which indicated that cultivars with upright growth habit had close genetic relationship. Five dwarf cultivars were grouped to one clade, supported by 81% bootstrap value, indicating that they probably derived from a common gene pool. These results demonstrated that AFLP markers are powerful for determining genetic relationships in ornamental peach. The genetic relationships among ornamental cultivars established in this study could be useful in ornamental peach identification, conservation, and breeding.**

Prunus persica (L.) Batsch (ornamental peach) is a small deciduous tree of Rose Family (Rosaceae). The plant has glabrous branchlets, serrulate leaves, and subsessile flowers blooming before the unfolded leaves during the early spring. The showy flowers range from pink to red, white, bicolor or tricolor. Growth habits range from upright, dwarf, weeping, to fastigiate. Leaf colors vary from green to purple (Hu et al., 2003). All these characteristics make the ornamental peach an excellent plant for urban landscapes and gardens.

Ornamental peach had been cultivated in China for thousands of years before it was introduced to western countries about three hundred years ago (Everett, 1967). Today it is grown in Asia, Europe, North America, South Africa, and Australia for its outstanding ornamental features and many new cultivars have been introduced in the nursery trades. However, ornamental peach nomenclature and classification in the literature are contradictory and confusing. Some ornamental peach cultivars have the same name in the literature, but do not have the similar morphological descriptions (Krussmann, 1986; Moore et al., 1993). Others have different names, but share identical morphological characteristics (Jacobson, 1996). It is difficult to classify ornamental peach taxa based only on morphological characteristics (Dirr, 1998). Modern technology can aid in clarifying nomenclature, and in determining genetic relationships.

Amplified fragment-length polymorphism (AFLP) has become a popular marker technique in plant genetics because it combines restriction digestion and amplification of DNA fragments, with no prior knowledge about the target genome required (Vos et al., 1995). Abundant polymorphisms and reproducibility have been proved to be the advantages of AFLP technique (Pejic et al., 1998; Powell et al., 1996; Russell et al., 1997). AFLP markers have been extensively and successfully used on detecting genetic diversity and analyzing cultivars relationships for agronomic crops, fruit trees and ornamental plants, such as *Cephalotaxus* (Zhang et al., 2000), *Dahlia* (Debener, 2002), daylily (Tomkins et al., 2001), *Dendranthema* (Zhou and Dai, 2002), *Dieffenbachia* (Chen et al., 2004), *Lagestroemia* (Pooler, 2003), *Philodendron* (Devanand et al., 2004), plum (Goulao et al., 2001), *Prunus mume* (Ming and Zhang, 2003), and sweet cherry (Struss et al., 2001, 2003; Tavaud et al., 2001; Zhou et al., 2002).

Previous studies of fruiting peach cultivars (Aranzana et al., 2001, 2003; Dirlewanger et al., 1998; Manubens et al., 1999; Shimada et al., 1998) have shown that AFLP technique produces a high degree of polymorphic markers per assay, which could provide an efficient system for detection and analysis of fruiting peach cultivars.

In this study, therefore, AFLP was applied to estimate genetic relationships of ornamental peach taxa, providing insights into their classification and further breeding.

Materials and Methods

Plant materials. Fifty-one ornamental peach taxa, which originated from *P. persica* and *P. davidiana*, were used in this study. They were collected from the following botanical gardens and arboreta: Beijing Botanical Garden, Beijing, China (BBG), National Institute of Fruit Tree Science, Tsukuba, Japan (JAPAN), and the JC Raulston Arboretum at North Carolina State University, Raleigh, North Carolina, USA (JCRA) (Table 1). The relationships among these cultivars were described by Hu et al. (2003) based on their morphological features.

DNA extraction. Total genomic DNA was isolated from silica gel dried leaves using a DNeasy Plant Mini Kit (Qiagen Inc., Chatsworth, Calif.) and following the manufacturer's protocols. DNA concentration was quantified using an Eppendorf BioPhotometer (Brinkmann Instruments, Inc., Westbury, N.Y.). All DNA samples were diluted or concentrated to a uniform concentration of 80 µg/mL for the following AFLP procedures.

AFLP procedure. Amplified fragment length polymorphism restriction, ligation, and preselective amplification reactions were conducted according to the Perkin Elmer AFLP Plant Mapping Protocol (PE Applied Biosystems, Foster City, Calif.) with some modifications suggested by Zhang et al. (2000) except for using MseI adaptor sequence plus CAT, CTC combining with EcoRI adaptor sequence plus ACT, ACC, and AGG.. Amplifications were electrophoresed at 3000 V and 50 °C for 2.5 h on an automated DNA Sequencer (model ABI 377; PE, Applied Biosystems). To avoid contamination from adjacent samples, the odd numbered lanes were first loaded, then the even numbered lanes were loaded after about one-minute run.

AFLP data analysis. For each primer combination, the amplified fragments were analyzed using GeneScan software (version 3.1. Perkin-Elmer, Applied Biosystems) equipped with ABI 377. The presence and absence of a specific

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marker were scored as 1 and 0, respectively, for each sample, generating a data matrix. The data set was then imported to PAUP (PAUP 4.0, Swofford, 2002). Pairwise distance comparisons were calculated and phenetic trees were constructed using the unweighted pair group method with arithmetic average (UPGMA) in PAUP. Conversion to genetic distance D_{xy}, was obtained by the following equation: $D_{xy} = 1 - S_{xy}$ (data not presented)[$S_{xy} = 2N_{xy}/(N_x + N_y)$], where S_{xy} is the genetic similarity between cultivar x and y; N_{xy} is the number of bands shared between cultivar x and y; and N_x and N_y were the number of bands for cultivar x and y, respectively.

Results and Discussion

In total, 275 markers, whose sizes ranged from75 to 500 base pairs (bp), were generated using six EcoRI/MseI AFLP primer combinations of 51 ornamental peach taxa. Among them, 256 markers were polymorphic. The number of markers for each taxon ranged from 90 to 140 (mean =120, Table 2).

Based on 275 useful AFLP markers, genetic distances among the cultivars were found to be ranged from 0.044 to 0.404 (data not presented). The greatest distance (0.404) was between *P. davidiana* 'BBG1' and *P. persica* 'Clarisse', 'Zhu Fen Chui Zhi', 'Genpaishidare', and 'Corinthian White', respectively. This result was not surprising given that genetic distances among the cultivars derived from different species are expected to be higher than those among the cultivars selected within a species.

Two major clades were recognized in the UPGMA tree, one being accessions of *P. davidiana* (CD), and the other containing cultivars of *P. persica* (CP) (Fig. 1). *Prunus davidiana* formed an outgroup to *P. persica*, which indicates that *P. davidiana* is genetically distant from other ornamental peach taxa derived from *P. persica*. The clade *davidiana* (CD) had three taxa derived from *P. davidiana* (*P. davidiana* var. *alba*, *P. davidiana* var. *rubra*, and *P. davidiana* 'BBG1') and supported by 100% bootstrap value. The genetic distance within these three taxa is 0.16, while the average distance of these three taxa to all other taxa originated from *P. persica* is 0.339. Obviously, these three taxa are closely related to each other compared with ornamental peach taxa derived from *P. persica*. *Prunus davidiana* 'BBG1', a new cultivar selected by Beijing Botanical Garden (manuscript in preparation), has upright twisted branches, single pink flowers, and a more narrow growth habit than the standard

Table 1. Taxa used in this study and their parentage and key characteristics.

Taxon	Name	Parentage	Key characteristics
1	*Prunus persica* 'Terutemomo'[z]	(Houki Momo × 'Akashidara') F_2	Fastigiate, pink flower, double
2	'Corinthian Mauve'[y]	One seedling selected from 'NC174RL' × Pillar 271	Fastigiate, rose pink flower, double
3	'Teruteshiro'[y]	(Houki Momo × 'Sansetsu Shidare') F_2	Fastigiate, white flower, double
4	'Corinthian White'[y]	One seedling selected from 'NC174RL' × Pillar 64	Fastigiate, white flower, double
5	'Corinthian Rose'[y]	One seedling selected from 'NC174RL' × Pillar 248	Fastigiate, rose pink flower, red-leaved
6	'Corinthian Pink'[y]	One seedling selected from 'NC174RL' × Pillar 172	Fastigiate, pink flower, red-leaved
7	'Houki Momo'[z]	Unknown	Fastigiate, pink and white flower, double
8	'Shiroshidare'[z]	'Akashidare' OP seedlings selection	Weeping, white flower, single
9	'Lv E Chui Zhi'[x]	Unknown	Weeping, white flower, double
10	'Akashidare'[z]	Unknown	Weeping, red flower, single
11	'Hong Yu Chui Zhi'[x]	Unknown	Weeping, red flower, double
12	'Clarisse'[y]	Unknown	Weeping, pink flower, double
13	'Zhu Fen Chui Zhi'[x]	Unknown	Weeping, pink flower, double
14	'Dai Yu Chui Zhi'[x]	Unknown	Weeping, light pink flower, double
15	'Genpaishidare'[z]	Unknown	Weeping, pink and white flower, single
16	'Yuan Yang Chui Zhi'[x]	Unknown	Weeping, pink and white flower, double
17	'Wu Bao Chui Zhi'[x]	Unknown	Weeping, pink and light pink flower
18	'Dan Ban Shou Fen'[x]	Unknown	Dwarf, pink flower, single
19	'Shou Fen'[x]	Unknown	Dwarf, pink flower, double
20	'Liang Fen Shou Xing'[x]	Unknown	Dwarf, bright pink flower, double
21	'Shou Bai'[x]	Unknown	Dwarf, white flower, double
22	'Dan Ban Shou Hong'[x]	Unknown	Dwarf, red flower, single
23	'Shou Hong'[x]	Unknown	Dwarf, red flower, double
24	'NCSU Dwarf Double Red'[y]	Unknown	Dwarf, pink flower, double
25	'Xia Yu Shou Xing'[x]	Unknown	Dwarf, pink and white flower, double
26	'Red Dwarf'[z]	('Akame' × Juseito) F_2	Dwarf, pink flower, single, red-leaved
27	'Bonfire Patio'[y]	Tsukuba No.2 open-pollinated	Dwarf, pink flower, single, red-leaved
28	'Dan Fen'[x]	Unknown	Upright, pink flower, single
29	'Beijing Zi'[x]	Unknown	Upright, pink flower, single, red-leaved
30	'Dan Hong'[x]	Unknown	Upright, red flower, single
31	'Dan Bai'[x]	Unknown	Upright, white flower, single
32	'Han Hong Tao'[x]	Unknown	Upright, red flower, double
33	'Er Se Tao'[x]	Unknown	Upright, pink flower, double
34	'Zan Fen'[x]	Unknown	Upright, pink flower, double
35	'Bi Tao'[x]	Unknown	Upright, pink flower, double
36	'Hong Bi Tao'[x]	Unknown	Upright, red flower, double
37	'Fei Tao'[x]	Unknown	Upright, red flower, double
38	'Wu Bao Tao'[x]	Unknown	Upright, pink red flower, double
39	'Ju Tao'[x]	Unknown	Upright, pink flower, double
40	'Kyou Maiko'[y]	Kikoumomo bud mutation	Upright, red flower, double
41	'Bai Bi Tao'[x]	Unknown	Upright, white flower, double
42	'Wan Bai Tao'[x]	Unknown	Upright, white flower, double
43	'Zi Ye Tao'[x]	Unknown	Upright, red flower, double, red-leaved
44	'BBG2'[x]	Mutation selected from 'Zi Ye Tao'	Upright, red flower, bicolor leaves red and green
45	'Unriu Momo'[z]	Nectarine mutation	Twisted twig, pink flower, single
46	'Bai Hua Shan Bi Tao'[x]	Unknown	Hybrid, white flower, double
47	'Fen Hua Shan Bi Tao'[x]	('He Huan Er Se Tao' × 'Bai Hua Shan Bi Tao') F_2	Hybrid, pink flower, double
48	'Fen Hong Shan Bi Tao'[x]	('Jiang Tao' × 'Bai Hua Shan Bi Tao') F_2	Hybrid, rose pink flower, double
49	*P. davidiana* var. *rubra*[x]	Unknown	Pink flower, single
50	*P. davidiana* 'BBG1'[x]	Selected from *P. davidiana* var. *rubra*	Fastigiate, pink flower, single
51	*P. davidiana* var. *alba*[x]	Unknown	White flower, single

[z]Japan.
[y]JCRA.
[x]BBG.

upright *P. davidiana*. The genetic distance between this new cultivar and the other two *P. davidiana* varieties is 0.16 (genetic similarity is 0.84 shown on Fig. 1).

The *P. persica* clade (CP) consisted of four subgroups, clade PR (red-leaved clade), clade PT (twisted clade), clade PU (upright clade), and clade PG [growth habit clade (including fastigiate, weeping, and dwarf)]. Clade PR included two red-leaved cultivars ('Zi Ye Tao' and 'BBG2'), with 100% bootstrap support. 'BBG2' is a bud-sport from the normal red-leaved 'Zi Ye Tao'. It was selected by Beijing Botanical Garden in 2001. Compared with normal red-leaved cultivars, 'BBG2' has unique purple and green bicolor leaves. The lowest genetic distance from this clone to 'Zi Ye Tao' was 0.12.

The clade PT consisted only of cultivar 'Unriu Momo'. It is the only documented ornamental peach cultivar with twisted twigs. The plant was a mutant selected from nectarine seedlings (Yoshida et al., 2000). It is separate from all other ornamental peach taxa within the clade *Persica* (CP) in the UPGMA tree. The average genetic distance to other *P. persica* taxa is 0.237. It is possible that this cultivar originated independently and might be an important germplasm source for further ornamental peach breeding.

Twenty taxa were clustered into the clade PU, which had the common morphological trait of upright branches. Eighteen out of 20 upright ornamental peach cultivars in this study were in this clade. Other growth habits, such as fastigiate (with narrow growth habit, columnar shape), weeping (with pendulous branches, umbrella shape), and dwarf (dense and compact, with short internodes and long narrow leaves), were mostly grouped to their relevant clade. These results demonstrate that growth habit probably is a hierarchy in ornamental peach systematics, supporting the conclusion from Hu et al. (2003).

Three hybrids, 'Bai Hua Shan Bi Tao', 'Fen Hua Shan Bi Tao', and 'Fen Hong Shan Bi Tao', were grouped into the clade PU. The average distance (0.192) of these three hybrids to other cultivars in the clade *Persica* (CP) is less than that to the clade *Davidiana* (0.254), but farther from other taxa in the clade *Persica* (CP).

The position of 'Bai Hua Shan Bi Tao', 'Fen Hua Shan Bi Tao', and 'Fen Hong Shan Bi Tao' in the PU clade supports the hybrid origin of these cultivars. Both 'Fen Hua Shan Bi Tao' and 'Fen Hong Shan Bi Tao' share 'Bai Hua Shan Bi Tao' (Hu and Zhang, 2001) as the pollen parent. The female parent of 'Fen Hua Shan Bi Tao' was 'He Huan Er Se Tao' (upright type, double, pink flowers) and the female parent of 'Fen Hong Shan Bi Tao' was 'Jiang Tao' (upright type, double, red flowers). According to the UPGMA tree, these cultivars have a closer relationship to *P. persica* than *P. davidiana*. 'Bai Hua Shan Bi Tao' shares 28 bands with 'Bai Bi Tao' and 11 bands with *P. davidiana* var. *alba*. Together, these three taxa share 61 bands in six primer combinations (Table 3). This result supports the conclusion drawn by Zhang et al. (1997) and Zhang (1998) that *P. persica* 'Bai Hua Shan Bi Tao' probably is a hybrid of *P. persica* 'Bai Bi Tao' and *P. davidiana* var. *alba*.

The two red-leaved dwarf cultivars 'Red Dwarf' and 'Bonfire Patio' clustered with the upright clade (PU), suggesting that upright cultivars may have been involved in the breeding and development of these dwarf cultivars. 'Red Dwarf', released by Yoshida and Seike (1974) in Japan, originated from hybridization of a red-leaved, upright parent and a green-leaved, dwarf peach. 'Bonfire Patio', released by Moore et al. (1993) in US, is an open pollinated seedling from a red-leaved upright type cultivar. Its closest relative is 'Beijing Zi', which is a red-leaved upright type cultivar. The morphological characters of 'Beijing Zi' are similar to the parent of 'Bonfire Patio'. The AFLP data is consisted with known origin of these two red-leaved cultivars, indicating that AFLP is a useful tool to elucidate putative breeding history of ornamental peach cultivar.

'Red Dwarf', 'Bonfire Patio', 'Beijing Zi', and 'Dan Fen' all have single pink flowers, while *P. persica* 'Dan Hong' has single red flowers and 'Dan Bai' has single white flowers. These six cultivars clustered as a subgroup in the PU clade (Fig. 1). The other 11 double flowered cultivars were clustered into another subgroup. AFLP data suggest that the number of petals can be used to subcategorize ornamental peaches.

Within the clade PG there were two subgroups, the clade PGD (dwarf clade) and the clade PGM (mixed clade of fastigiate, weeping, and dwarf; Fig. 1). The clade PGD included five

Table 2. Useful AFLP bands for 51 ornamental peach taxa.

Taxon[z]	E-ACT/ M-CAT	E-AGG/ M-CAT	E-ACC/ M-CAT	E-ACT/ M-CTC	E-AGG/ M-CTC	E-ACC/ M-CTC	Total
1	24	20	11	18	17	18	108
2	30	19	27	18	18	15	127
3	28	22	23	19	17	18	127
4	31	23	30	18	15	15	132
5	26	23	29	19	16	18	131
6	26	17	28	18	18	14	121
7	25	22	32	19	17	17	132
8	25	20	33	18	18	14	128
9	25	19	25	15	13	13	110
10	30	18	23	19	16	15	121
11	31	19	25	17	22	17	131
12	21	17	25	20	18	15	116
13	27	18	27	18	20	14	124
14	26	18	28	19	15	14	120
15	31	17	25	17	19	17	126
16	22	22	25	20	15	19	123
17	23	21	23	18	20	16	121
18	13	18	24	19	18	18	110
19	8	18	25	14	20	15	100
20	24	17	29	11	17	15	113
21	7	18	20	19	20	18	102
22	11	17	22	17	19	15	101
23	9	18	21	19	19	18	104
24	26	17	28	17	19	15	122
25	22	16	26	19	19	18	120
26	28	20	26	16	18	14	122
27	30	21	32	19	18	17	137
28	27	18	26	16	20	14	121
29	29	27	27	19	20	18	140
30	29	17	30	15	19	12	122
31	30	16	20	9	17	11	103
32	28	22	20	20	19	12	121
33	26	21	22	20	18	10	117
34	25	21	24	18	13	10	111
35	30	23	22	19	18	10	122
36	29	21	27	17	18	10	122
37	24	21	24	19	17	10	115
38	23	23	17	17	21	11	112
39	34	21	19	19	21	13	127
40	33	22	21	17	19	12	124
41	29	23	26	18	19	10	125
42	29	23	27	18	17	12	126
43	35	27	21	18	19	12	132
44	39	30	15	20	22	7	133
45	36	28	30	18	16	11	139
46	35	19	15	16	15	7	107
47	33	18	21	19	21	9	121
48	22	20	34	16	20	11	123
49	23	25	16	14	19	7	104
50	21	26	4	14	17	8	90
51	23	28	17	14	18	9	109
Mean	26	20	24	18	18	13	119
Markers	81	53	52	30	37	22	275

[z]The taxon number corresponds with the number in the first column of Table 1.

dwarf cultivars ('Dan Ban Shou Fen', 'Shou Fen', 'Shou Bai', 'Dan Ban Shou Hong', and 'Shou Hong') and had 81% bootstrap support. The average distance between these five dwarf cultivars is 0.085. All of these five cultivars are very dense and compact, with short internodes, long narrow leaves. The results show that these five dwarf cultivars are more closely related to each other than to other cultivars. They probably share common germplasm.

All seven fastigiate cultivars and 10 weeping cultivars examined in this study clustered into the PGM subgroup. 'Terutemomo', 'Teruteshiro', and 'Houki Momo' are from Japan. The first two cultivars were released by Yamazaki et al. (1987). 'Houki Momo' is an ancient and unique cultivar from the Edo Era in Japan (Yoshida et al., 2000). 'Terutemomo' was derived from a cross of 'Houki Momo' and 'Akashidare' (clustered into the PGM as well). 'Teruteshiro' was derived from a cross of 'Houki Momo' and a weeping habit cultivar with double pink flowers, which has very similar morphological characters to 'Zhu Fen Chui Zhi' (also in the PGM as well). 'Corinthian Mauve', 'Corinthian White', 'Corinthian Rose', and 'Corinthian Pink' are four column-shaped cultivars released by Werner et al. (2000a, 2000b, 2000c, 2001). They are derived from 'Houki Momo'. 'Shiroshidare' is an open pollinated seedling from 'Akashidare' (Yoshida et al., 2000). 'Genpaishidare' is from the National Institute of Fruit Tree Science, Tsukuba, Japan. 'Clarisse' is from the JC Raulston Arboretum at North Carolina State University, Raleigh, North Carolina, US. 'Lv E Chui Zhi', 'Dai Yu Chui Zhi', 'Yuan Yang Chui Zhi', 'Hong Yu Chui Zhi', and 'Wu Bao Chui Zhi' are from Beijing Botanical Garden, China. All these 17 weeping and fasitigiate cultivars were clustered in one clade, suggesting that the cultivars with weeping and fastigiate growth habits have closer genetic relationships.

The cultivars with similar flower colors and flower types were scattered in different clades. 'Kyou Maiko' (double red flowers) was a bud mutation from 'Ju Tao' (double pink flowers; Yoshida et al., 2000). The distance between these two cultivars was 0.055. Both have narrow, chrysanthemum-like petals. The distance between 'Zan Fen' (double pink, peony-like flowers) and 'Fei Tao' (double pink, peony-like flowers) is 0.076. Within the dwarf clade, the distance between 'Shou Bai' (double white flowers) and 'Shou Hong' (double red flowers) was 0.044. Within the mixed clade (PGM), the distance between 'Hong Yu Chui Zhi' (weeping, double red flowers) and 'Zhu Fen Chui Zhi' (weeping, double pink flowers) was 0.055. No distinguished cluster was formed from the

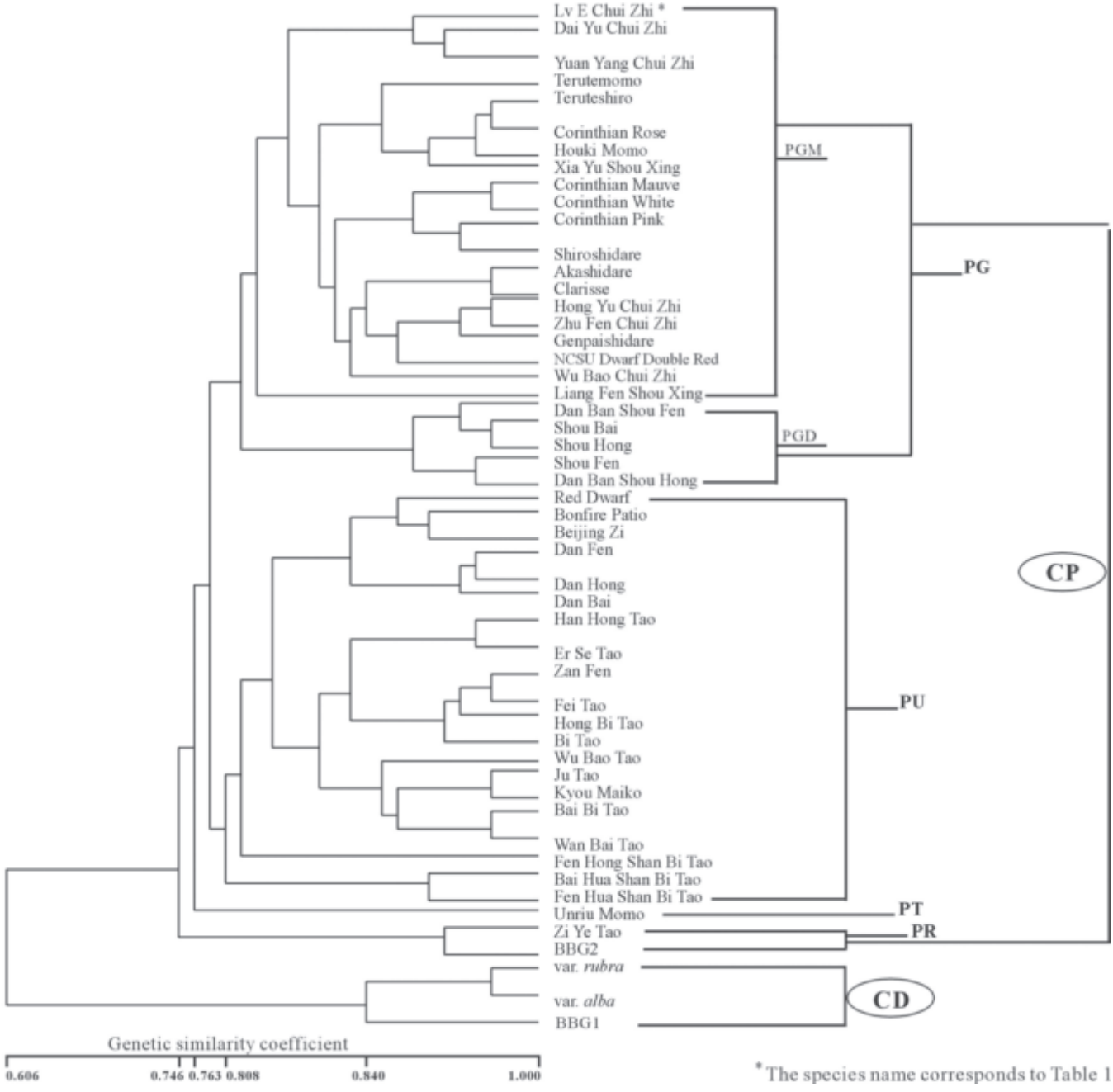

Fig. 1. UPGMA tree of 51 ornamental peach taxa based on AFLP markers.

Table 3. Comparison of AFLP bands of *Prunus persica* 'Bai Hua Shan Bi Tao' and its relatedness to *P. persica* 'Bai Bi Tao' and *P. davidiana* var. *alba*.

Primer	Total bands of *P. persica* 'Bai Hua Shan Bi Tao'	Shared bands with only *P. persica* 'Bai Bi Tao'	Shared bands with only *P. davidiana* var. *alba*	Shared bands with both *P. persica* 'Bai Bi Tao' and *P. davidiana* var. *alba*	Unique bands not present in *P. persica* 'Bai Bi Tao' or *P. davidiana* var. *alba*
E-ACT/M-CAT	35	13	6	12	4
E-AGG/M-CAT	19	3	0	16	0
E-ACC/M-CAT	15	2	0	12	1
E-ACT/M-CTC	16	4	1	10	1
E-AGG/M-CTC	15	5	3	7	0
E-ACC/M-CTC	7	1	1	4	1
Total	107	28	11	61	7

same flower color or type. This AFLP result indicates that flower color and type might not be useful in the classification of ornamental peaches.

Conclusion

AFLP fingerprinting data generated from this study provide a picture of genetic relationships of ornamental peaches. Ornamental peach taxa are mostly derived from *P. persica*. However, *P. davidiana* may have also been involved in ornamental peach cultivars' breeding and development. Both the growth habit and the number of petals are important characters in the systematics of ornamental peaches. Results of this study will likely provide guidance for future germplasm collection, conservation, and breeding of ornamental peaches.

Literature Cited

Aranzana, M.J., M.C. Vicente, and P. Arus. 2001. Comparison of fruit and leaf DNA extracts for AFLP and SSR analysis in Peach (*Prunus persica*). Acta Hort. 546:297–300.

Aranzana, M.J., J. Carbo, and P. Arus. 2003. Using amplified fragrant-length polymorphisms (AFLPs) to identify peach cultivars. J. Amer. Soc. Hort. Sci. 128:672–677.

Chen, J., R.J. Henny, D.J.Norman, P.S. Devanand, and C.C.T. Chao. 2004. Analysis of genetic relatedness of *Dieffenbachia* cultivars using AFLP markers. J. Amer. Soc. Hort. Sci. 129:81–87.

Debener, T. 2002. Molecular markers as a tool for analysis of genetic relatedness and selection on ornamentals, p. 329–345. In: A. Vainstein (ed.). Breeding for ornamentals: classical and molecular approaches. Kluwer Academic Publishers, London, U.K.

Devanand, P.S., J. Chen, R.J. Henny, and C.C.T. Chao. 2004. Assessment of genetic relationships among *Philodendron* cultivars using AFLP markers. J. Amer. Soc. Hort. Sci. 129:690–697.

Dirlewanger, E., S. Duha, M.A. Viruel, and R. Saunier. 1998. Identification of peach varieties using molecular markers. Acta Hort. 465:69–78.

Dirr, M.A.1998. Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation and uses. 5th ed. Stipes Publishing, Champaign, Ill.

Everett, T.H. 1967. New illustrated encyclopedia of gardening. N.Y. Bot. Garden Press, New York.

Goulao, L., L. Monte-Corvo, and C.M. Oliver. 2001. Phenetic characterization of cultivars of plum (*Prunus* sp.) by high multiplex ratio markers: Aplified fragment length polymorphism and inter-simple sequence repeats. J. Amer. Soc. Hort. Sci.126:72–77.

Hu, D. and X. Zhang. 2001. Breeding of early ornamental peach cultivars (In Chinese). J. Beijing For. Univ. 23:39–40.

Hu, D., Z. Zhang, X. Zhang, and Q. Zhang. 2003. The Germplasm preservation of ornamental peach cultivars. Acta Hort. 620:395–402.

Jacobson, A.L. 1996. North American landscape trees. Ten Speed Press, Berkeley, Calif.

Krussmann, G. 1986. Manual of cultivated broadleaved trees and shrubs. Timber Press, Portland, Ore.

Manubens, A., S. Lobos, Y. Jadue, M. Toro, R. Messina, M. Liadser, and D. Seelenfreund. 1999. DNA isolation and AFLP fingerprinting of nectarine and peach varieties (*Prunus persica*). Plant Mol. Biol. Rpt. 17:255–267.

Ming, J. and Q. Zhang. 2003. Identification of Meiflower cultivars using AFLP fingerprint (in Chinese). J. Beijing For. Univ. 25(Spec.):46–48.

Moore, J.N., R.C. Rom, S.A. Brown, and G.L. Klingaman. 1993. 'Bonfire' dwarf peach, 'Leprechaun' dwarf nectarine, 'Crimson Cascade' and 'Pink Cascade' weeping peaches. HortScience 28:854.

Pejic, I., P. Ajmone-Marsan, M. Morgante, V. Kozumplick, P. Castiglion, G. Taramino, and M. Motto. 1998. Comparative analysis of genetic similarity among maize inbred lines detected by RFLPs, SSRs, and AFLPs. Theor. Appl. Genet. 97:1248–1255.

Pooler, M.R. 2003. Molecular genetic diversity among 12 clones of *Lagerstroemia fauriei* revealed by AFLP and RAPD markers. HortScience 38:256–259.

Powell, W., M. Morgante, C. Andre, M. Hanafey, J. Vogel, S. Tingey, and A. Rafalski. 1996. The comparison of RFLP, RAPD, AFLP, and SSR markers for germplasm analysis. Mol. Breed. 2:225–238.

Russell, J.R., J.D. Fuller, M. Macaulay, B.J. Hatz, A. Jahoor, W. Powell, and R. Waugh. 1997. Direct comparison of level of genetic variation among barley accessions detected by RFLPs, AFLPs, SSRs, and RAPDs. Theor. Appl. Genet. 95:714–722.

Shimada, T., T. Yamamoto, H. Yaegaki, M. Yamaguchi, M. Yoshida, and T. Hayashi.1998. Application of AFLP to molecular genetic analysis in peach. J. Jpn. Soc. Hort. Sci. 68(1):67–69.

Struss, D., M. Boritzki, K. Glozer, and S.M. Southwick. 2001. Detection of genetic diversity among populations of sweet cherry (*Prunus avium* L.) by AFLPs. J. Hort. Sci. Biotechnol. 76:362–367.

Struss, D., R.Ahmad, S.M. Southwick, and M. Boritzki. 2003. Analysis of sweet cherry (*Prunus avium* L.) cultivars using SSR and AFLP markers. J. Amer. Soc. Hort. Sci. 128: 904–909.

Swofford, D.L. 2002. PAUP, phylogenetic analysis using parsimony. version 4.0b10. Sinauer, Sunderland, Mass.

Tavaud, M., A. Zanetto, F. Santi, and E. Dirlewanger. 2001. Structuration of genetic diversity in cultivated and wild cherry varieties using molecular markers. Acta Hort. 546:263–269.

Tomkins, J.P., T.C. Wood, A. Westman, and R.A. Wing, 2001. Evaluation of genetic variation in the daylily (*Hemerocallis* spp.) using AFLP markers. Theor. Appl. Genet. 102:489–496.

Vos, P., R. Hogers, M. Bleeker, M. Reijans, T. van de Lee, M. Hornes, A. Frijters, J. Pot, J. Peleman, M. Kuiper, and M. Zabeau. 1995. AFLP: A new technique for DNA fingerprinting. Nucleic Acids Res. 23:4407–4414.

Werner, D.J., S.M. Worthington, and L.K. Snelling. 2000a. Peach tree named 'Corinthian Mauve'. U.S. Patent PP11576.

Werner, D.J., S.M. Worthington, and L.K. Snelling. 2000b. Peach tree named 'Corinthian Rose'. U.S. Patent PP11504.

Werner, D.J., S.M. Worthington, and L.K. Snelling. 2000c. Peach tree named 'Corinthian White'. U.S. Patent PP11493.

Werner, D.J., S.M. Worthington, and L.K. Snelling. 2001. Peach tree named 'Corinthian Pink'. U.S. Patent PP11902.

Yamazaki, K., M. Okabe, and E. Takahashi. 1987. New broomy flowering peach cultivars 'Terutebeni', 'Terutemomo', and 'Teruteshiro' (in Japanese). Bul. Kanagawa Hort. Expt. Sta. 34:54–56.

Yoshida, M. and K. Seike. 1974. 'Red Dwarf', the new red-dwarf peach (in Japanese). Bul. Fruit Tree Res. Sta. A(1):25–32.

Yoshida, M., K. Yamane, Y. Ijiro, N. Fujishige, M. Yamaguchi, and E. Takahashi. 2000. Studies on ornamental peach cultivars. Bul. College Agr. Utsunomiya Univ. 17(3):1–14.

Zhang, C. 1998. Studies on evolution relationships between ornamental peach cultivars (in Chinese). MS thesis. Beijing For. Univ.

Zhang, D., M.A. Dirr, and R.A. Price. 2000. Discrimination and genetic diversity of *Cephalotaxus* accessions using AFLP markers. J. Amer. Soc. Hort. Sci. 125:404–412.

Zhang, X., Y. Wang, and G. Wang. 1997. Observation and comparisons on the pollen morphology of peach-blossom cultivars germplasm resources (in Chinese). J. Beijing For. Univ. 19(2):57–62.

Zhou, C. and S. Dai. 2002. Analysis on *Dendrathema* using AFLP (in Chinese). J. Beijing For. Univ. 10:71–75.

Zhou, L., F. Kappel, C. Hampson, P.A. Wiersma, and G. Bakkeren. 2002. Genetic analysis and discrimination of sweet cherry cultivars and selections using amplified fragment length polymorphism fingerprints. J. Amer. Soc. Hort. Sci. 127:786–792.