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The Nordic Gene Bank's Prunus clone archive in Finland II Local races of plum

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The morphological variation in 104 local races of plum (*Prunus domestica* subsp. *domestica* L.) in the Nordic Gene Bank's Prunus clone archive in Pälkäne, Southwest Finland was examined. Each tree was described using 37 characteristics. On the basis of fruit characteristics the local races were classified into three main groups. The largest one was the red plum group, the yellow plum group being the second largest. Victoria-type plums, which have not been reported to occur in Finland before and which resemble the English cultivar 'Victoria', make up the third group. Victoria-type plums proved to be fully and red plums partly self-compatible, whilst the yellow plums were self-incompatible. All the local races of plum were evaluated for their possible further use. Two of them were selected for commercial propagation.

Key words: *Prunus domestica*, red plum, self-compatibility, Victoria, yellow plum

Introduction

European plum *(Prunus domestica* L.) is usually thought to have been derived from a cross between the cherry plum or myrobalan (*P. cerasifera* Ehrh.) and the sloe or blackthorn (*P. spinosa* L.) (Nilsson 1989). However, according to Eryomine (1990) several species have participated in the origin of *P. domestica*, e.g. *P. cerasifera*, *P. spinosa*, *P. salicina* Lindley (the Japanese plum), *P. armeniaca* L. (apricot), *P. persica* (L.) Batsch (peach), and *Microcerasus microcarpa*. Whereas, Zohary (1992) states that genomically the European plum has nothing to do with *P. spinosa*, but evolved directly from the variable *P. cerasifera* stock. Whatever its origins, it is certain that the European plum possesses a rich genetic potential. On the other hand, a narrow genetic base among major cultivars limits major

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plum production to specific areas, and makes plum also susceptible to disease and insect attack. On the contrary, great diversity exists in native plum species, and they have wide adaptibility. (Ramming and Cociu 1990).

Plum has been cultivated in Finland for at least 300 years (Webster and Hiirsalmi 1980). In the past plum trees were imported to Finland from Russia, Estonia, Germany and Sweden. In 1929 for example, in total 36 plum cultivars were known to occur in Finland (Collan 1934). Imported cultivars were cultivated on rootstocks, and were often damaged or killed by winter frosts. New races have arisen, however, through their seedlings. Local Finnish plums 'Yleinen punaluumu' ('Common red plum') and 'Yleinen keltaluumu' ('Common yellow plum') have been widely cultivated as own-rooted plants. They have been propagated and spread using root suckers, and many slightly different clones of them occur (Collan 1926).

Besides being used for fruit production, plum trees are also excellent ornamentals. The commercial plum production in Finland is limited to the coastal areas, but in home gardens plums are also grown in Central Finland. Until recently, mainly foreign plum trees have been offered for sale in Finland, and foreign cultivars have been recommended for cultivation. The problem in Finnish plum growing is the insufficient degree of winter hardiness in recommended foreign cultivars. The hardiest germplasm and the plant material that is genetically adapted to Nordic conditions, is to be found among the native cultivars.

The objective of this study was to examine the morphological variation in local races of plum in the Nordic Gene Bank's Prunus clone archive at the Agricultural Research Centre of Finland, Häme Research Station in Pälkäne.

Material and methods

The local races of plum were identified in Southern and Southeastern Finland, and planted as root suckers on the experimental field in Pälkäne in 1988. No plant protection chemicals were used. More detailed information is given by Palonen et al. (1998).

The description and documentation of this plum material was carried out during the seasons 1992 and 1993. In 1992, the Prunus clone archive in Pälkäne (61°20' N, 24°13'E) consisted of 178 plum trees representing 104 different local races. Each plum tree was described using the characteristics used by the Nordic Gene Bank. The descriptions were complemented with some further characteristics used by the International Union for the Protection of New Varieties of Plants (UPOV). In total, 37 characteristics were used for the description of each tree. Characteristics observed were related to growth habit, flowering, fruit set, as well as external and internal properties of the fruits. The descriptions were made mainly in 1992 and supplemented, using UPOV descreptors, in 1993. They will be saved in the Nordic Gene Bank's database BIRS.

In 1993, the self-compatibility of 20 local plum races was studied. Two branches per tree were isolated before floral anthesis by enclosing them in acrylic bags, and two branches were marked and used as open pollinated controls. Self-pollination was aided by brushing the isolated flowers carefully with a small clean brush as the pollen was shed. This was carried out daily during the flowering period. The control branches were allowed to be pollinated by insects. The number of self-pollinated flowers and the number of open pollinated flowers was counted, and later, the number of green fruits was recorded. Percentage fruit set from both self-pollination and open pollination was calculated. The self-compatibility of a local race was estimated by the ratio of percentage fruit set with self-pollination to percentage fruit set with open pollination. The data on the ratios were analyzed with ANOVA-1-test of MSTAT-C -program (Michigan State University 1989).

All the local plum races were evaluated for their possible further use. The main criteria were: fruit set, fruit quality, winter-hardiness, resistance to diseases and pests, and ornamental val-

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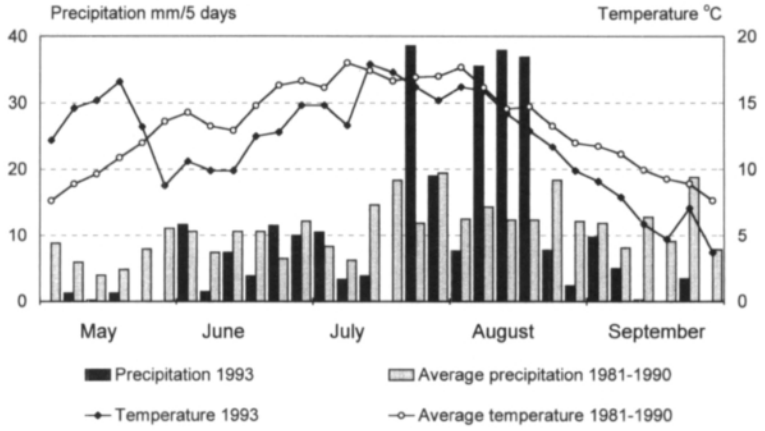

Fig. 1. Mean temperature and precipitation/5 days from May to September in 1993 and the long term averages in Pälkäne.

ue. Each local race was either recommended for further study or classified to be of no value.

Results

The trees flowered freely in 1992. The differences in time of flowering were negligible. The fruit set was very high, but cold weather in autumn delayed fruit ripening. In 1993, the flowering season was very early on account of exceptionally warm weather in May. The period of flowering for all clones varied from 14 to 25 May. No differences in time of flowering were observed. The fruit set was very high and plums were harvested from 6 to 21 September. Also, in several trees fruits were prevented from reaching their full maturity by night frosts.

Pests were very abundant. Mites (*Panonychus ulmi*), gall mites and aphids were found on most plum trees. Brown rot (*Monilia* sp.) destroyed a lot of the fruits. Gummosis occurred commonly in the fruits of many plum trees.

Beginning in early August, especially with the local races of red plum types, leaves became greyish, developed some brown spots and then abscissed prematurely. Trees exhibiting these symptoms also shed their fruits just prior to maturity. In early September, many trees were almost leafless even though no diseases were observed. It is thought that the symptoms may have been attributable to physiological disorder, caused by the exceptional weather conditions in conjunction with the abundant fruit set. In the previous autumn 1992, premature fall of snow occurred unexpectedly on 8 October, before the trees had shed their leaves. In the following spring 1993, growth started abruptly, stimulated by a period of extremely warm weather in May. At the beginning of the growing season, plants may also have suffered from drought, whilst in June, on the contrary, it was exceptionally cold and in August the weather was cold and rainy (Figure 1).

On the basis of fruit characteristics the local plum races were classified into three main groups (Table 1). In six cases, two trees representing the same local race proved to be different.

Group 1) Red plums. (77 local races) The fruits are have a red skin colour and tree growth habit is erect. Brown rot, gummosis and pest sensitivity occurred commonly. The local races of the red plum type can be grouped further into subgroups, as follows:

1a) The ground colour in the fruits is greenish, but most of it is covered by red colour. The fruits are round, the fruit length varies from 24 to 27 mm, and the fruit weight from 6.5 to 12.5 g.

Table 1. The local plum races in the Prunus clone archive classified into groups. Local races marked with a plus-sign (+) are recommended for further study, e and t indicate the first and the second tree in the field, respectively.

Group 1) Red plums			Group 2) Yellow plums	Group 3) Victoriatype plums
1a)	1b)	1c)	2a)	
Punaluumu	6 Rymättylä	166 Vihti +	84 t ? +	Häkkisen Victoria +
14 Tammela +	9 ?	206 Joutseno	171 Koski, HL	209 Juva
18 ?	11 , Rymättylä	218 Pukkila +	191 Ruotsinpyhtää	210 Juva +
32 ? +	13 Halikko	235 Kangaslampi +	193 t Lapinjärvi +	211 Juva
36 Parainen	16 Alastaro		194 Lapinjärvi +	213 Mikkeli mlk. +
46 Tuusula	23 Jokioinen		226 Elimäki	229 Hankasalmi +
51 Vantaa +	33 Kemiö	1d)	250 Mikkeli mlk. +	230 Hankasalmi +
56 e Nurmijärvi	48 Helsinki	Vaarin luumu +		232 Laukaa +
61 Espoo +	57 Siuntio	40 Rymättylä +		233 e Jyväskylä +
62 t Espoo	59 Sammatti	50 Tuusula +	2b)	234 Toivakka +
169 Järvenpää	78 Lohja		Savion Keltaluumu +	236 Kangasniemi +
170 Kärkölä	80 Sammatti		8 Rymättylä +	237 Haukivuori +
179 Kuusankoski	106 Porlammi +	1e)	22 Halikko	238 Anttola +
181 Valkeala +	129 e Anjalankoski	64 Sammatti +	42 Naantali +	239 Joroinen +
187 t Anjalankoski +	164 Vihti	72 Lohja mlk. +	49 Helsinki +	240 Sulkava +
190 Ruotsinpyhtää	165 Vihti +	251 e Janakkala	63, Inkoo +	241 Kerimäki +
192 e Ruotsinpyhtää +	167 Vihti		68 ? +	242 Parikkala +
199 t Hamina	168 Vihti		70 Vantaa +	245 e Imatra +
207 Joutseno	175 Orimattila	244 Ruokolahti +	173 Asikkala	248 Anttola +
212 Mikkeli mlk.	178 Orimattila	(differs from all the	177 Orimattila +	290 Hankasalmi
233 t Jyväskylä +	184 Elimäki	others)	187 e Anjalankoski +	
247 Imatra	186 Anjalankoski		188 t Kotka	
249 Hirvensalmi	188 e Kotka		204 Taipalsaari +	
300 ? +	192 t Ruotsinpyhtää		219 Pukkila +	
	193 Lapinjärvi		220 Sipoo +	
	195 Porlammi		231 Hauks. +	
	197 Pyhtää +			
	222 Perniö +			
	224 Anjalankoski +			
	225 Anjalankoski			
	246 Imatra			
	251 t Janakkala			

1b) The fruits are red with a greenish ground colour. They are oblong. The fruit length varies from 26 to 32 mm, and the fruit weight from 9 to 16 g. Fruit ripening is the earliest in the whole red plum group.

1c) The ground colour of the fruits is yellow, which is partly covered by red colour. The fruits are oblong. The fruit length varies from 27 to 31 mm, and the fruit weight from 10 to 13 g. The taste is delicious.

1d) The fruits are very dark red. They are slightly oblong. The average fruit length is 28 mm and fruit weight 12 g. They resemble the native cultivar 'Vaarin luumu' (Uosukainen 1990).

1e) The fruit colour is dark violet red. The fruits are oblong, the average fruit length being 33 mm, and the average fruit weight 14 g. The fruits ripen distinctly later than the other red plums.

Group 2) Yellow plums. (23 local races) The fruit colour is yellow. Yellow plums can be divided further into two subgroups, as follows:

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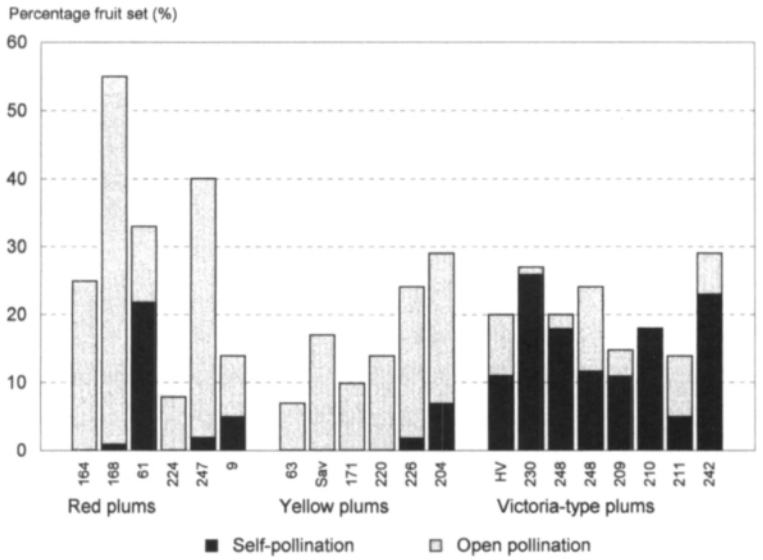

Fig 2. Percentage fruit set of local plum races by self-pollination and open pollination. Local races within each group are in the geographical order from west to east.

2a) The fruits are oblong. The fruit length varies from 28 to 32 mm, and the fruit weight from 11 to 15 g. Fruit ripening is rather late but earlier than in group 2b.

2b) The fruits are typical of the cultivar 'Yleinen keltaluuumu'. They are drop-shaped. The fruit length varies from 35 to 40 mm, and the fruit weight from 15 to 22 g. Fruit ripening is late. The taste is mostly delicious and sweet. The trees are densely-crowned, very healthy and resistant to pests. The leaves are big and leathery.

Group 3) Victoria-type plums. (20 local races) Plums of this group resemble the English cultivar 'Victoria'. Fruits are purple with a yellow ground colour. The fruits are oblong, the upper side being slightly narrower. The fruit length varies from 29 to 33 mm, and the fruit weight from 12.5 to 15.0 g. Fruit ripening is late. The branches are typically drooping, and the leaves are big and glossy. The trees are relatively healthy and resistant to pests.

Table 2. The average percent fruit set in each group of local plum races by self-pollination (self) and by open pollination (open), and their ratio (self/open).

	Percent fruit set (%)		
	self	open	self/open (%)
Red plums	5.0	29.2	18.3b
Yellow plums	1.5	16.8	5.3b
Victoria-type plums	15.5	19.6	88.0a
Overall average	8.2	21.7	41.3

Values followed by the same letter are not significantly different at P = 0.05 by Tukey's test.

Two distinct geographical distribution areas were observed. The local races of red plum and yellow plum type were mainly collected from the area south of 61° northern latitude. Victoria-type plums were identified mainly from a triangle shaped distribution area between 61° and 62°20' northern latitude, bordered by Lappeenranta and Kerimäki in east and Laukaa in west. Victoria-type plums have not been reported to occur in Finland before.

In all of the plum material examined, the percentage of fruit set varied; by self-pollination from 0 to 26, the average being 8.2, and by open pollination from 7 to 55, the average being 21.7. The Victoria-type plums proved to be self compatible, while yellow plums were the least self compatible group (Table 2 and Figure 2.)

The local races recommended for further study are marked with a plus sign (+) in Table 1. In the red plum group, 34% of local races were

recommended for further study, and in the yellow plum group and Victoria-type plum group 74% and 85%, respectively. The rest of the local races are considered to be of no value, on account of their poor fruit set, poor fruit quality, their sensitivity to pests, minimal ornamental value, or a bad health status of a tree. Two local races were selected for commercial propagation; a yellow plum from Savio and a Victoria-type plum from Anttola. The plants for sale under names 'Savion Keltaluumu' and 'Anttolanluumu' will be micropropagated and own-rooted.

Discussion

A great deal of genetic variation was shown to be present in the local plum races in the Prunus clone archive. This is because both eastern and wertern cultivars have been imported to Finland. Some of these cultivars, or their rootstocks, survived and new progenies have been generated from their seeds and have been distributed through root suckers from garden to garden. 'Yleinen punaluumu' is an old local plum, which has been widely cultivated in Finland. Its origin is unknown and many different genotypes occur (Meurman 1947). Five distinctly different groups of red plum types were found to occur in the Prunus clone archive. Some variation also existed within each group. There are contradictory reports concerning the self-compatibility of 'Yleinen punaluumu'. According to Meurman (1947), Uosukainen (1990) and Laurinen et al. (1992) 'Yleinen punaluumu' is self compatible. In contrast, according to Hämet-Ahti et al. (1992) it is self incompatible and needs a pollinator. On the basis of earlier knowledge and our results, local races of red plum types are concluded to be partly self-compatible, but using a pollinator is to be recommended, as it improves yield. The red plum type fruits reached maturity early enough in autumn to avoid frost damage. However, because of the physiological symptoms described above occurring in the trees of this group, and because they are susceptible to pests and diseases, the red plum type local races are not recommended for cultivation.

Two different types of yellow plum occurred in the clone archive. The local races of group 2a having an oblong fruit form, may have genes of the cultivar 'Reine Claude d'Oullins' in their germplasm. The local races of group 2b are rather typically of the 'Yleinen keltaluumu' type. The local races in the yellow plum group proved to be self incompatible, as 'Yleinen keltaluumu' has been reported to be (Nilsson 1989, Hämet-Ahti et al. 1992). Suitable pollen donors for 'Yleinen keltaluumu' are the cultivars 'Yleinen punaluumu' and 'Victoria' (Laurinen et al. 1992). Yellow plum trees were healthy and their fruit taste was mostly delicious. The only problems associated with their culture seem to be their late fruit ripening and the self-incompatibility. The fruits did not reach the full maturity in autumn but were damaged by night frosts in September.

Victoria-type plums occur generally in Russia (V. L. Vitkovsky, personal communication, 1993). They are considered to be even hardier than 'Yleinen punaluumu'. The local races of this type in the clone archive were registered mainly in Eastern Finland, which supports the hypothesis that they have been carried to Finland from Russia. The English cultivar 'Victoria' is known to be self compatible (Redalen 1984, Nilsson 1989), as were the Victoria-type local races in the Prunus clone archive. Fruits of this group did not reach their full maturity early enough in autumn.

Although red plums formed the largest group in the clone archive, most of them were classified to be of no value. Most probably, new cultivars fit for cultivation in Nordic conditions will be found among yellow plums and Victoria-type plums. Victoria-type plums have not been presented in Finnish literature before. They are considered to be very hardy and the fruits are of good quality. Yellow plum 'Savion keltaluumu' and Victoria-type plum 'Anttolan luumu' are already in commercial propagation.

Surprisingly, there were no blue fruited plum

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races in the Prunus clone archive. In addition to the 'Common red plum' and the 'Common yellow plum', a 'Common blue plum' has also occurred in Finland (Meurman 1947, Salonen and Jaatinen 1961). It is mentioned to be not as hardy as red and yellow ones, and that may be the reason for it not occurring any more. In Sweden (Fernqvist 1993), and in Estonia (Jaama 1971), several blue fruited plum cultivars occur. A new Finnish plum cultivar 'Sinikka', which is a progeny of 'Czar', also has blue-coloured fruits (Takala et al. 1990).

The general problem and a restricting factor to Finnish plum growing is that only in the most favourable growing seasons can the fruits reach full maturity in autumn. Based on the results of this study, local races do not possess potential germplasm for accelerated fruit ripening.

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SELOSTUS

Pohjoismaisen geenipankin Prunus-kokoelma Suomessa II Luumukannat

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Maatalouden tutkimuskeskus ja Helsingin yliopisto

MTT:n Hämeen tutkimusasemalla sijaitsevan Pohjoismaisen Geenipankin *Prunus*-kokoelman luumukannoissa (*Prunus domestica* L.) esiintyvää geneettistä muuntelua kartoitettiin arvioimalla morfologisia ominaisuuksia. Vuonna 1993 oli elossa 177 luumupuuta, jotka edustivat 104 eri maatiaiskantaa. Jokaisesta puusta laadittiin 37 ominaisuutta sisältävä kuvaus, joka tallennettiin Pohjoismaisen geenipankin BIRS-tietokantaan.

Ominaisuuksiensa perusteella luumukannat jaettiin kolmeen ryhmään. Suurimman ryhmän muodostavat punaluumut, jotka on kerätty pääosin eteläisimmästä Suomesta. Ne jaettiin edelleen viiteen alaryhmään. Toiseksi suurin ryhmä oli niinikään Etelä-Suomesta kerätyt keltaluumut, jotka jaettiin vielä kahteen alaryhmään. Kolmannen ryhmän luumut, Victoria-tyyppiset, muistuttavat englantilaista 'Victoria' lajiketta ja ne on kerätty Mikkelin läänistä ja Jyväskylän ympäristöstä. Victoria-tyyppiset luumut osoittautuivat itsepölytyskykyisiksi. Punaluumut olivat osittain itsepölytyskykyisiä ja keltaluumut itsepölytyskyvyttömiä.

Kartoituksen yhteydessä kaikkien luumukantojen mahdollinen käyttöarvo arvioitiin käyttäen kriteereinä puun koristearvoa, satoisuutta, sadon laatua ja tauti- ja tuholaiskestävyyttä. Keltaluumukanta Saviolta ja Victoria-tyyppinen kanta Anttolasta on otettu taimituotantoon MTT:n Laukaan tutkimus- ja valiotaimiasemalle.