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Mume, a Possible Source of Genes in Apricot Breeding

UNAROJ BOONPRAKOB AND DAVID H. BYRNE[1]

Abstract

Mume, which is in section Armeniaca with apricots, has a wide genetic variability. Crosses between mume and apricots produce fertile hybrids while plum X apricot hybrids are semifertile. Therefore, mume might serve as a good source of genes in apricot breeding. This paper reviews the potential of mume to enhance apricot breeding programs.

Introduction

Mume or Japanese apricot is generally grown for its fragrant and attractive flowers in Japan and North America. However, in China, Japan, and Taiwan it is grown for its fruit. Because its fresh fruits are inedible, mume is pickled or used in liquor. The genetic variability within the species is wide in characteristics such as fruit size, chilling requirement, and disease resistance. Mume is one of the stone fruit species that has been seldom used in breeding. Given its genetic variability, mume could be utilized in breeding programs to develop low chilling stone fruit with good adaptation to humid conditions. This article describes the genetic, fertility, and evolutionary relationship of mume with other stone fruits and discusses its potential use in apricot breeding.

The genus *Prunus* is within the family Rosaceae and includes such diverse crops as cherry plums, cherries (subgenera: Eucerasus); plums, apricots (subgenera: Prunophora); peaches and almonds (subgenera: Amygdalus) (Figure 1). Among this diverse array, plums show the most diversity (19). The subgenera Prunophora includes both apricots (section: Armeniaca) and plums (sections: Euprunus and Prunocerasus). The cultivated apricot has been developed mainly from the European group within the species *P. armeniaca*. Among the five groups within the apricot species, this is the most recently evolved and least vari-

[1]Texas A&M University, Department of Horticultural Sciences, College Station, Texas 77843-2113.

Table 1. The fertility relationships of selected *Prunus* spp.

Species	Intercross to produce fertile F_1	Intercross to produce semi-fertile F_1	Intercross to produce sterile F_1	No intercross
P. armeniaca	*P. sibirica* (10, 15,[a])	*P. besseyi* (2, 10, 13)	*P. domestica* (6x) (6, 10, 15)	*P. avium*
or	*P. mandshurica* (2, 10, 15,[a])	*P. salicina* (2X) (6, 11, 20)	*P. spinosa* (4x) (13)	*P. fruticosa*
P. mume	*P. dasycarpa* (5, 11, 15)	*P. cerasifera* (2x) (11, 16,[a])	*P. dulcis* (10, 15)	
		P. americana (5)	*P. persica* (4, 7)	

[a]Mehlenbacher, S. A. (Personal communication).

able (1). Consequently there are extreme restrictions to the adaptability of the present-day cultivars of apricots. Germplasm with adaptation to low-chill humid conditions is not known. This adaptation exists within plums and mume.

Mume, *Prunus mume* (Sieb.) Sieb. & Zucc., is a deciduous tree in family Rosaceae. Mume is in subgenera Prunophora, section Armeniaca. Other species in this section are:

Apricots [*P. armeniaca* L.]
Siberian apricots [*P. sibirica* L.]
Manchurian apricots [*P. mandshurica* (Maxim.) Koehne]
Black or purple apricots [*P. dasycarpa* Ehrh.]
Briancon apricots [*P. brigantina* Vill.]

The taxonomic similarities and differences of these related species are described (Figure 2).

Distribution and Evolution

Mume is indigenous to China. It is distributed in the mountainous area in central China along the 30th parallel to South Korea, and in eastern China along the coast (21) (Figure 3). The climate is warmer and more humid as compared to that of north China and Manchuria where other related species are distributed. Mume is well adapted to humid areas (14, S. A. Mehlenbacher, personal communication).

The related species in section Armeniaca have their characteristic ecological preference; that is, each adapts to a distinct habitat. Apricots are distributed in western China and Irano-Caucasian area where the ecological environment is harsh and dry. Mume, on the other hand, is found in the area of eastern China along the coast where the climate is humid. Both Siberian

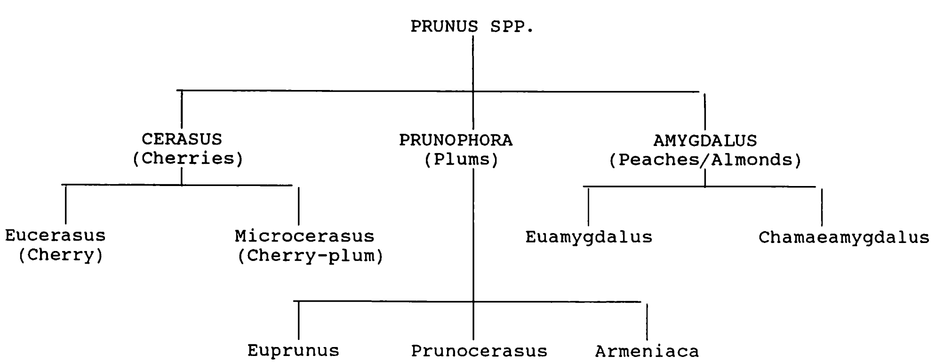

Figure 1. Evolution of *Prunus* spp. **Source: Watkins, 1979.**

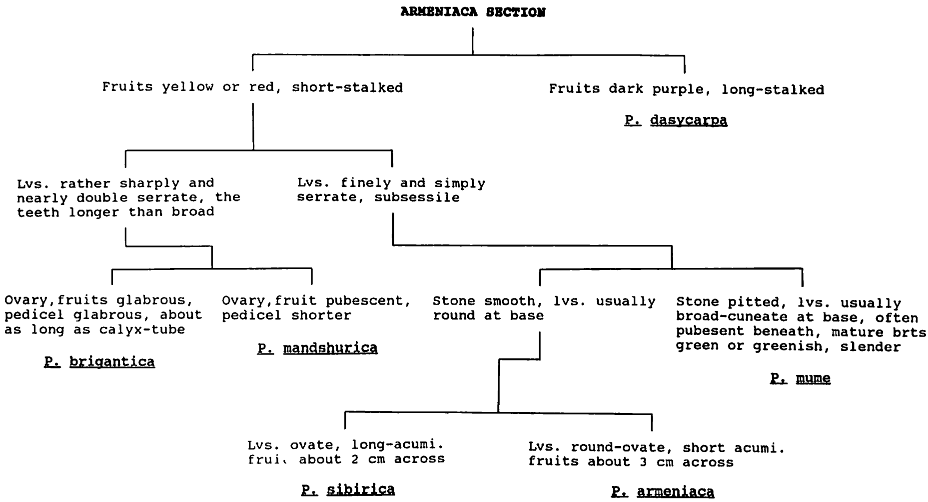

Figure 2. The morphological similarities and differences within section Armeniaca.
Source: Rehder, 1940.

and Manchurian apricots have better cold resistance because they grow in the area above the 35th parallel.

The mode of speciation within this section appears to be geographic in nature. Upon geographic isolation of plant populations within this group, selection for adaptation and genetic drift has combined to cause morphological and adaptation differentiation between the groups although they still remain cross-fertile.

Fertility Relationships

Mume contains both self-fertile and self-infertile types. Among the cultivars studied in Japan, almost half were self-unfruitful due to self-incompatibility or poor pollen production. Moreover, cross-incompatibility between certain cultivars is suspected (18).

The data on cross fertility relationships is summarized in Table 1. The cross between mume and apricot can produce fertile F_1 hybrids (10, 20). Since apricots and mume are cross fertile and little cross fertility information is available for mume, the cross-fertility of mume was assumed to be similar to that of apricot.

Biosystematic classification is based on the fertility relationships determined by artificial hybridization experiments. According to this hierarchical classification, ecotypes within an ecospecies can intercross to produce fertile F_1. Ecospecies within a coenospecies can produce semi-sterile F_1 and coenospecies within the same comparium can be intercrossed with difficulty to produce sterile F_1 hybrids. Accessions in different compariums cannot be crossed (8).

The proposed biosystematic species classification of *Prunus* spp. (Figure 4) indicates that mume is cross fertile with the four apricot species as well as partially cross fertile (produces semi-fertile F_1) with the plum group. The cherry-plum group is partially fertile with all groups except peach/almond group whereas the peach, almond and cherry groups are not cross fertile with the apricot or plum groups. It has been suggested that the plum group could be used to expand the adaptation of apricot (3) but given that mume

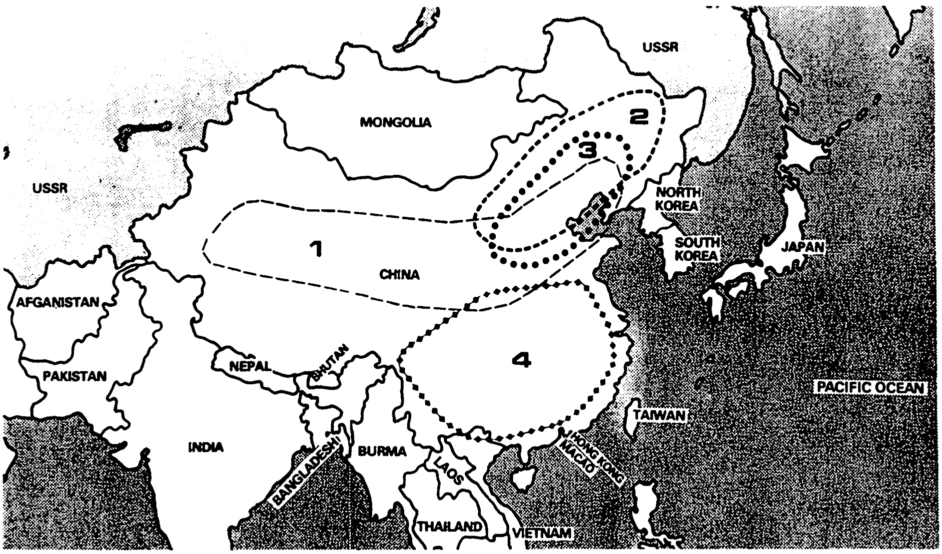

Figure 3. The distribution of species in section Armeniaca.
—— 1 = *P. armeniaca* ----- 2 = *P. sibirica*
●●● 3 = *P. mandshurica* -●-●-4 = *P. mume* **Source: Yu, 1979**

exhibits better crossability with apricot than plums do, *P. mume* could also be used as a source of adaptation genes.

Potential in Breeding

Mume has been grown widely; however, it has not received much attention from plant breeders. All cultivars grown in the United States and many in the Far East are grown for their attractive flowers and not for fruit production. Of the cultivars grown for fruit production, there is much genetic variability. There are over 300 named cultivars (12) which vary in vigor and growth habit from shrubs to small trees (8 m), ranging in fruit size from 3 g in 'Koume' to 67 g in 'Sumomoume' and in chilling requirement from 150 hours to over 600 hours. In addition, most commercial cultivars tend to have good resistance to diseases such as crown gall (*Agrobacterium tumefaciens*) (17), shothole (*Sclerotinia cinerea* and *S. laxa*) (14).

Given the genetic traits available and the crossability of mume and apricot, the development of low-chill apricot cultivars with good disease resistance is possible. Experience with peach indicates that three to four generations would be needed to recover adequate fruit quality from the initial hybrid population to create new apricot cultivars with the good adaptation to the mild-winter humid zones of the world.

Conclusion

The genetic variation for growth habit, fruit size, chilling requirement, and disease resistance make mume a potential source of genes for developing apricots with wide adaptation. Since mume hybrids with apricot give fertile progeny, and plum X apricot hybrids have fertility problems, mume appears to be a good source of adaptation traits for apricot breeding. Nevertheless, breeding programs that directly use mume are rare. Mume should be used as a source of genetic variability in apricot breeding.

ECOSPECIES 1

P. mume
P. armenica
P. mandshurica
P. sibirica
P. dasycarpa

ECOSPECIES 2

P. cerasifera
P. salicina
P. americana
P. angustifolia
P. mexicana

ECOSPECIES 3

P. persica
P. davidiana

ECOSPECIES 4

P. dulcis
P. webbi

ECOSPECIES 5

P. besseyi
P. pumila
P. tomentosa

ECOSPECIES 6

P. avium
P. fruticosa

COENOSPECIES I

Ecospecies 1
Ecospecies 2
Ecospecies 5

COENOSPECIES II

Ecospecies 3
Ecospecies 4

COENOSPECISE III

Ecospecies 5
Ecospecies 6

COMPARIUM A

Coenospecies I
Coenospecies II

COMPARIUM B

Coenospecies III

Figure 4. The biosystematic classification of *Prunus* spp.

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An Intergeneric Hybrid of *Microcitrus Papuana* and *Citrus Medica*

H. C. Barrett[1]

Abstract

The first reported hybrid between *Microcitrus papuana* H. F. Winters, Brown River finger lime, and *Citrus medica* L., citron, is recorded and some of the prominent attributes of this new intergeneric hybrid are described. The hybrid was made for the purpose of creating a genetic bridge for gene exchange between species and genera in the orange subfamily Aurantioideae of the family Rutaceae. Important barriers to gene exchange are ovule and pollen sterility in the F_1 generation and the widespread occurrence of apomixis in the Aurantioideae. Attributes of this hybrid most relevant to citrus breeding are small stature, remontant flowering and fruiting, ease of rooting from cuttings, very short reproductive cycle, zygotic reproduction, sufficient degree of fertility to function in further breeding, and tenderness to cold. The hybrid appears to have a significant potential for improving citrus rootstocks in the areas of size control and ease of propagation. The attribute of a very short reproductive cycle, inherited from *M. papuana*, may have a potential for obtaining precocious bearing in seedling progenies, and thus reduce the juvenility component of the long time period between origination and completion of validation testing.

Intergeneric hybridization is a technique used by plant breeders to transfer genes from one genus to another. It is infrequently used, but may be resorted to in situations where it is necessary to transfer desired traits present in one genus to another genus where these traits are absent or inadequately expressed. In the USDA-ARS Citrus Improvement Program, intergeneric hybridization has been used with considerable frequency in some segments of the program because of the reason cited. The purpose of this paper is to record the first reported

[1]U.S. Department of Agriculture, Agricultural Research Service, Horticultural Research Laboratory, 2120 Camden Road, Orlando, FL 32803.