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'Marsh' Grapefruit[1]

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All of the commercially significant citrus scion species are of Old World origin, with the notable exception of the grapefruit (*Citrus x paradisi* Macf.), which presumably originated in the Caribbean region in the 17th century (2, 3, 9, 14). Grapefruit germplasm, in the form of seed or young plants, was introduced to Florida by Count Odette Phillippi around 1823 (12). It was from this original introduction that all of the major grapefruit cultivars are believed to be derived. Seeds and budwood were distributed throughout Florida from Phillippi's grove, and the cultivar 'Marsh' originated from one of these propagants.

Two somewhat conflicting stories have been published regarding the origin of the 'Marsh' grapefruit. One was presented by H. J. Webber (17) in reiteration of an account by E. H. Tison in the *Los Angeles Times* (16). This story holds that 'Marsh' originated in 1879 or 1880 on the farm of Mr. John Hancock, near Lakeland, Florida, as a bud sprout from a plowed up, broken root piece of another grapefruit tree that produced white-fleshed, seedy fruit. E. H. Tison, a nurseryman, became aware of this seedless grapefruit around 1886, and he received seeds and budwood from Hancock for propagation in his nursery. Tison sold his nursery in 1890 to C. M. Marsh, who advertised and promoted this clone that now bears his name.

Robinson (11) published an alternative account of the details surrounding the origin of 'Marsh' that disputes some of the specifics of the former version. Robinson asserts that 'Marsh' originated as one of three grapefruit seedlings planted by Mrs. Rushing on a farm later purchased by William Hancock (John Hancock's father) in 1862. Robinson interviewed surviving family members, including John Hancock's brother, who claimed that the original tree was a large seedling, more than 30 years old, when buds were first collected for propagation, and not the much younger tree described in Webber's account (11, 17). The question surrounding the exact details of the origin of 'Marsh' grapefruit, specifically whether it originated as a seedling or a bud sprout from a root piece, will likely remain unanswered. What is certain is that the 'Marsh' seedless grapefruit originated near Lakeland, Florida in the late 19th century. Several people recognized the unique seedless characteristic that distinguished this clone from the standard seeded grapefruit, and they began to propagate it. C. M. Marsh was the individual most responsible for promoting the new cultivar after he purchased all of the existing nursery stock in the Lakeland area, so it seems appropriate that it bears his name.

'Marsh' grapefruit trees are vigorous, large, and capable of producing good crops annually. The attractive fruit possess smooth, thin, and shiny yellow rinds when grown in suitable subtropical environments. The flesh is pale buff, tender, and quite juicy. Minimum fruit maturity standards can be met by October in Florida, but fruit can remain on the tree as long as the following March or April. This on-tree storage ability provides growers with flexibility when making harvest and marketing decisions. The flavor of

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'Marsh' fruit is typical of, but less pronounced than, the seedy 'Duncan' grapefruit. It was the characteristic of producing very few seeds per fruit (usually three or less) that attracted attention to 'Marsh' and served as the basis for its early promotion; this remains a factor in the continued popularity of 'Marsh' with consumers. The good tolerance of storage conditions (on-tree and post-harvest) and shipping ability of 'Marsh' fruit has allowed market expansion and exploitation. The vigor and productivity of the tree, especially when compared with several of the newer, pigmented grapefruit cultivars, has encouraged continued grower interest and acceptance of 'Marsh.' Several other seedless white-fleshed clones have arisen throughout the grapefruit producing regions of the world, most notably 'Cecily' from South Africa (8). However, none have surpassed the popularity of 'Marsh,' the first seedless grapefruit known.

'Marsh' became the leading grapefruit cultivar shortly after its introduction. Despite the increasing popularity of pigmented grapefruit, it remains the leading cultivar grown today. The United States leads in world grapefruit production, producing nearly 45% of the world total in the 1990/1991 season (4), and Florida grapefruit production accounted for nearly 85% of the U.S. total (15). Over 48% of the Florida grapefruit crop in 1990-1991 was 'Marsh.' 'Marsh' predominates, likewise, in other grapefruit producing countries.

The amount of 'Marsh' grapefruit produced relative to pigmented types has been declining with increased consumer preference for pigmented grapefruit. In 1971, nearly 24,000 hectares (> 52% of the total) of 'Marsh' grapefruit were grown in Florida, compared with less than 12,000 hectares (< 26% of the total) of pigmented grapefruit cultivars, mostly the 'Redblush' or 'Ruby Red' (15). By 1990, 'Marsh' hectarage in Florida decreased to slightly more than 19,000 (> 45% of the total), but pigmented varieties increased to more than 20,500 hectares (nearly 49% of the total). The decline in overall production and hectarage planted with 'Marsh' will continue. From July 1986 through June 1991, a total of 1,691,272 'Marsh' trees were produced by registered nurseries in Florida (34.8% of all registered grapefruit trees), but 3,087,728 registered pigmented grapefruit trees were grown (63.6% of the total) (Charles O. Youtsey, Chief of the Florida Bureau of Citrus Budwood Registration). The pigmented cultivars included 'Redblush' (for 'Ruby Red'), 'Star Ruby,' 'Flame,' 'Ray Ruby,' and 'Rio Red.' Although as a group the pigmented cultivars are being planted more than 'Marsh,' it is noteworthy that not one of these individually has been planted in greater number than 'Marsh.'

Grapefruit cultivars produce polyembryonic seeds that contain apomictic embryos (of nucellar origin), and few or no zygotic embryos, so most seedling progeny are genetically identical clones of the seed parent tree. 'Duncan' grapefruit has been used as a pollen parent in interspecific *Citrus* hybridization to produce several tangelo cultivars (hybrids of grapefruit with mandarin, *C. reticulata* Blanco). 'Marsh' grapefruit has not been widely used in hybridizations because of poor pollen fertility resulting from either spindle mechanism failure (10) or increased univalency (5). In addition to nucellar embryony and low fertility, those few grapefruit x grapefruit hybrid seedlings that can be produced by sexual hybridization exhibit general characteristics of inbreeding depression, and may not bear typical fruit.

Contemporary scholars of *Citrus* agree that grapefruit is more correctly considered an interspecific hybrid of *C. grandis* (L.) Osb. (pummelo) and *C. sinensis* (L.) Osb. (sweet orange), rather than a "true" species (1, 9, 14). The narrow germplasm base repre-

sented among grapefruit cultivars (resulting from its likely interspecific origin and the development of all cultivars from a single germplasm introduction) and the biological factors described above preclude utilization of hybridization and selection among grapefruit for genetic advance and cultivar development. Bowman and Gmitter (2, 3) have documented greater genetic diversity among grapefruit-like *Citrus* clones called "forbidden fruit," "shadette," "wild grapefruit," etc., found growing on various Caribbean islands. Some of these forms may provide breeding parents useful for grapefruit cultivar development because of their ability to produce zygotic seedlings at frequencies much greater than common grapefruit cultivars (author's unpublished data).

Mutation breeding, in the broadest sense, has been the only method used to develop new grapefruit cultivars. All grapefruit cultivars now grown originated either as nucellar seedlings or as bud sport mutations that exhibited some desirable phenotypic change; none have come from controlled hybridization. Naturally occurring and induced mutations have been exploited. Growers and scientists have selected new clones mostly on the basis of increased fruit pigmentation.

'Marsh' grapefruit has been the primary germplasm source for the diversification and selection process that has produced nearly all of the pigmented grapefruit cultivars. A 'Marsh' tree in Florida gave rise to a limb sport that bore fruit with slightly-pigmented pink flesh; this limb, discovered in 1913, became the bud source for the 'Thompson' (for 'Pink Marsh') grapefruit (8). Various limb sports that produced more intensely pigmented fruit were found on 'Thompson' grapefruit trees in Florida and Texas; these included 'Pawcett Red,' 'Burgundy,' and 'Redblush' (also known as 'Ruby Red,' the most widely grown pigmented variety) (13). 'Ruby Red' in turn gave rise directly to 'Ray Ruby' via spontaneous bud sport mutation (6), and to 'Rio Red' indirectly via bud sport mutation from an unreleased clone that resulted from irradiation of 'Ruby Red' budwood (7). 'Fawcett' gave rise to 'Henderson' via bud sport mutation; 'Flame' was selected from a 'Henderson' nucellar seedling population (13). 'Ray Ruby,' 'Rio Red,' and 'Flame' are the newest and most intensely pigmented cultivars (excluding 'Star Ruby'). With the sole exception of 'Star Ruby' grapefruit, all of the major contemporary pigmented grapefruit cultivars are descended from 'Marsh' by somatic mutation. Although 'Marsh' will decline in significance and production in response to consumer preference for pigmented grapefruit, its influence will continue in the future through the propagation of its somatic offspring.

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Tarnished Plant Bug Injury on Six Strawberry Cultivars Treated with Differing Numbers of Insecticide Sprays[1]

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Abstract

Six strawberry (*Fragaria x annassa* Duch.) cultivars known to vary in susceptibility to tarnished plant bug (*Lygus lineolaris* P. de B.) injury (apical seediness) were grown for two seasons under three insecticide regimes (three sprays, one spray and no spray) to determine if differences in susceptibility could be used to modify chemical controls for this insect. The most susceptible cultivars harbored more nymphs than the least susceptible cultivars. Increased marketable yield as a result of insecticides was most pronounced on susceptible cultivars. Differences in injury among cultivars were greatest when no insecticide was applied. 'Honeoye' and 'Sparkle' had the least apical seediness, followed by 'Redchief,' 'Guardian' and 'Kent.' 'Mic Mac' consistently had the highest level of injury. When insecticide applications were reduced, apical seediness did not increase significantly for cultivars exhibiting low susceptibility. Chemical name used: O, O-dimethylphosphorodithioate of diethylmercaptosuccinate (malathion).

Injury to strawberry fruit caused by tarnished plant bug (*Lygus lineolaris*) can result in serious economic loss to farmers in most regions of North America. This insect feeds on strawberry flowers and fruit causing a distinctive malformation of the fruit tissue described as "apical seediness" (12) and commonly called "buttoning" or "catfacing." As few as one tarnished plant bug per four flower clusters can cause significant economic loss in commercial fields (7, 11). The feeding destroys developing achenes and/or their supporting tissues, disrupting the export of auxin from achenes to the receptacle. Apical seediness occurs because of impaired receptacle development (1, 4, 8, 9).

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