

Ancestors, Origin, and some Descendants of the Queensland Strawberry 'Phenomenal'

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Abstract

'Phenomenal', a Queensland heritage cultivar bred in 1907, has recently gained importance in the strawberry industry in Australia as a source of resistance to charcoal rot (*Macrophomina phaseolina*) and Anthracnose crown rot (*Colletotrichum gloeosporioides*). We investigated and describe the origins and ancestors of 'Phenomenal' and some of its descendants as far as 'Kabarla' to document the pedigree of an important early subtropical cultivar in Australia.

The documentation of the pedigree of ancestors, include 'Pink's Prolific', 'British Queen', 'Black Prince', 'Keen's Imperial', 'White Carolina' (*Fragaria chiloensis*), 'Federator', 'La Margeurite' and 'Hudson's Bay', and the descendants include 'Majestic', 'Redlands Crimson', 'Earlisweet', and 'Kabarla'. There is an association of grandparentage through 'British Queen' with the high flavored 'Mieze Schindler'. 'Phenomenal' is also in the distant ancestry of some current cultivars in Queensland and Florida. The documentation provides information to enhance the use of pedigree analysis in current strawberry breeding programs.

The Queensland heritage cultivar, 'Phenomenal' (Fig 1.) has recently gained importance in the strawberry industry in Australia as a source of resistance to disease. 'Phenomenal' has moderate to high levels of resistance to sampled isolates of *Macrophomina phaseolina* (Gomez et al., 2017) and *Colletotrichum gloeosporioides* (Neal et al., 2017). 'Phenomenal' was a significant cultivar in subtropical Queensland during mid last century and is of current scientific interest. By 1946, 'Phenomenal' "was the basis of the strawberry industry of Queensland and the leading cultivar of the state" (Morgan, 1946).

'Phenomenal' has recently been found to carry resistance to a number of soil borne diseases of local significance (Gomez et al., 2017; Neal et al., 2017). 'Phenomenal', when compared to 'Camarosa', had higher levels of resistance to *Colletotrichum gloeosporioides* and *Macrophomina phaseolina*. From the analysis of hazard ratios, 'Festival' and 'Camarosa' were equally susceptible to *Colletotrichum gloeosporioides*, whereas at

any time after inoculation the mortality levels of 'Phenomenal' were only 24% those of 'Camarosa' (Neal et al., 2017). Furthermore 'Camarosa' showed 75% mortality from *Macrophomina phaseolina*, 23 weeks after inoculation compared with 'Phenomenal' which showed 0% mortality (Gomez



Fig. 1. 'Phenomenal' heritage strawberry, showing fruit, truss and leaves.

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et al., 2017). The disease resistance of ‘Phenomenal’, developed in non-fumigated soil, may be useful in developing resistant cultivars.

Barnes et al. (2017) investigated and identified the parents of ‘Phenomenal’ but little was known of its grandparents or their origins. Additionally, while ‘Phenomenal’ was reported to be in the ancestry of many modern subtropical cultivars from the Australian Strawberry Breeding Program (Barnes et al., 2017, Woolcock et al., 2017) reliable information was not readily available. This lack was largely because certain cultivars were bred prior to documentation of cultivars through the Plant Variety Rights and Plant Breeders Rights descriptions, which began in Australia in 1987 and 1994 respectively (Australian Government 1987, 1994).

Reliable pedigree descriptions are increasingly important for statistical analyses, for example through ASREML (Gilmour et al., 1995), where genetic connections through pedigree can be used to increase the efficiency of estimating parameters, including the levels of expression of plant traits and genetic variances, and, subsequently, clonal values, breeding values and heritability. DNA fingerprinting, e.g. using high-throughput genotyping for octoploid strawberry via the Affymetrix IStraw90 and IStraw35 single nucleotide polymorphism (SNP) arrays (Bassil et al., 2015), has been used to compare recorded and molecular pedigree relationships, and discrepancies between recorded and molecular pedigrees have been found (pers com. K. Hummer). Our initial investigations found that only one of eight ancestral predecessors of ‘Phenomenal’ was known to still exist. It is curated at the United States Department of Agriculture (USDA) Agricultural Research Service (ARS) National Clonal Germplasm Repository (NCGR) in Corvallis, OR, USA. Therefore since DNA fingerprinting was unlikely to be informative due to the unavailability of ancestral DNA, we focused our investigation

on recorded pedigree relationships.

Here we report our findings on the pedigrees of ancestors, and some descendants down to ‘Kabarla’ (Herrington, 1995), which was the first commercially important locally bred strawberry cultivar in this lineage described for Plant Breeders Rights (PBR) in Australia.

Materials and Methods

We conducted searches of scientific literature and media sources via the internet (mainly through ‘Trove’ - National Library of Australia), on-line digitized historical newspaper articles, reports and industry publications. This search traced backwards progressively from ‘Phenomenal’s’ parents to grand-parents etc. to the earliest record found, and forward through immediate descendants of ‘Phenomenal’ to the first official Plant Breeders Rights (PBR) registered description of a descendant cultivar, ‘Kabarla’.

Results and Discussion

History of the development of ‘Phenomenal’.

The heritage variety ‘Phenomenal’ originated in Chatsworth (26.1° S, 152.6° E) in subtropical Queensland, Australia, with a pioneer farmer and his son. The farmer, George Flay, grew strawberries on one hectare of his farm ‘Green Park’ near Gympie, which is about 150 km north of the capital city, Brisbane, in south east Queensland. In 1906-1907, George Flay’s son, Charles Flay, selected ‘Phenomenal’ from a cross between ‘Federator’ and ‘Pink’s Prolific’ (Flay, 1929).

While ‘Phenomenal’s’ immediate parents were ‘Pink’s Prolific’ and ‘Federator’, the ancestors of ‘Phenomenal’ (Fig.2) include: through ‘Pink’s Prolific’: ‘British Queen’, ‘Black Prince’, ‘Keen’s Imperial’, and ‘White Carolina’ (*Fragaria chiloensis*): and, through ‘Federator’: ‘La Margeurite’ and ‘Hudson’s Bay’.

Ancestors through ‘Pink’s Prolific’.

‘Pink’s Prolific’ was bred by Mr. James Pink at ‘The Badgens Nursery’ of Wellington

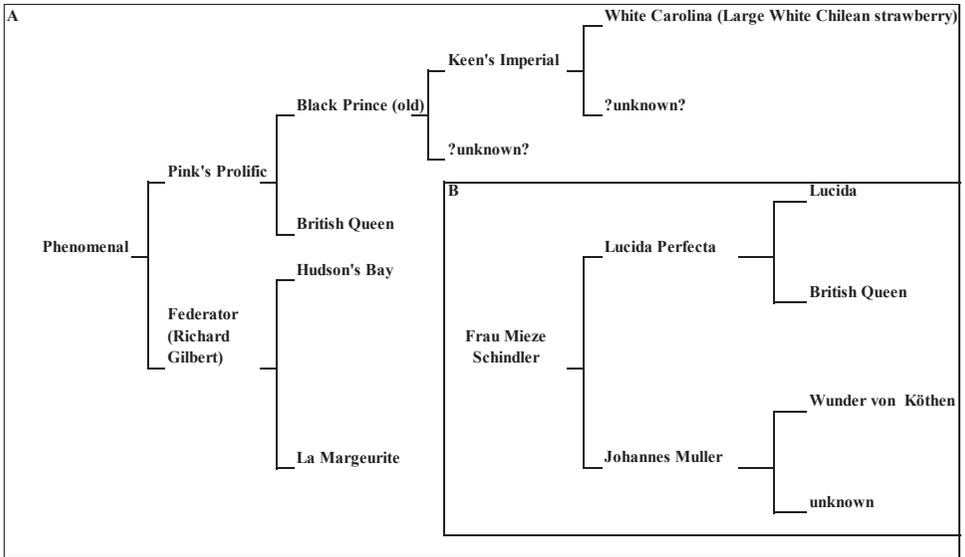


Fig. 2. ‘Phenomenal’ ancestors (Box ‘A’). Inset Box ‘B’ shows ‘Frau Mieke Schindler’ and ancestors indicating ‘British Queen’ as a common ancestor.

Point, near Brisbane, Queensland (Badgens, 1894), with the earliest record of ‘Pink’s Prolific’ being found in a newspaper article printed in 1893 (Agricola, 1893). While Flay (1929) claimed that James Mitchell ‘raised’ ‘Pink’s Prolific’, we accept Mr. James Pink as the originator, because ‘The Badgens Nursery’ made the earliest claim and was intimately involved with its production. The article describing ‘Pink’s Prolific’s’ parentage states “ ‘Pink’s Prolific’, is a cross between ‘British Queen’ and the ‘old’ ‘Black Prince’, having the fine flavor of the former with the cropping quality of the latter” (Week, 1894). It was stated in a newspaper that although “none of the new varieties come close to the flavor of the berries of old such as ‘Black Prince’, ‘Pink’s Prolific’ comes nearest, as it is of half parentage” (Horticultur, 1898).

However, literature reports the occurrence of two strawberry cultivars named ‘Black Prince’ (they are, ‘John Wilmot’s’, and ‘Cuthill’s’), which makes it confusing to determine which ‘Black Prince’ was crossed with ‘British Queen’ to produce ‘Pink’s

Prolific’. As we investigated further we found John Wilmot’s ‘Black Prince’, which was bred in 1820, was distinctly pistillate (Downing, 1847). ‘British Queen’, with which ‘Black Prince’ was crossed, was hermaphrodite. The second ‘Black Prince’ named Cuthill’s ‘Black Prince’ was raised by Mr. Cuthill around 1837 but no information on flower type was found. Because Cuthill’s ‘Black Prince’ was often referred to as ‘Cuthill’s’, we believe that the ‘old’ cultivar of ‘Black Prince’, as bred by Wilmot, was the genotype used in the cross resulting in ‘Pink’s Prolific’.

This ‘Black Prince’ (‘old’) strawberry was raised from the seed of ‘Keen’s Imperial’ by John Wilmot of Isleworth (Barnet, 1827, Burnett and Burnett, 1840). ‘Keen’s Imperial’ strawberry was raised from a seed of a ‘Large White Chili’ strawberry (‘White Carolina’) in around 1806. It should be noted that according to its description < <https://npgsweb.ars-grin.gov/gringlobal/accessiondetail.aspx?id=1446653> > in the NCGR ‘White Carolina’ was developed in

North Eastern America prior to 1700, and the 'white' fruit of 'White Carolina' tend to have a red blush (pers. comm. K. Hummer).

'British Queen' was developed by Joseph Myatt in Kent, England in 1841 (Mills, 2011). It had white flesh and exquisite flavor (Hogg, 1860). Of interest also is that the 'Frau Mieke Schindler' strawberry results from the cross between 'Lucida Perfecta' and 'Johannes Muller' (Darrow, 1966) and the former resulted from a cross between 'Lucida' and 'British Queen'. 'Frau Mieke Schindler' is said to be of very good taste and 'Mieke Schindler', a synonym for 'Frau Mieke Schindler', has the "preferred sensory quality of a few *F.×ananassa* cultivars", having high levels of methyl anthranilate (Ulrich and Olbricht, 2013). 'Mieke Schindler' has recently become available from retail outlets in Australia under the name 'Strasberry'. Additionally, a recent study (Olbricht and Ulrich, 2017) which evaluated concentrations of 82 volatile organic compounds (VOC) in 50 cultivars, found that 'Lucida Perfecta', one parent of which was 'British Queen', had the fourth highest VOC level, while additional white-fruited cultivars had the second, third and fifth highest levels of VOC.

Ancestors through 'Federator'.

'Federator' was bred by William Marsh of Marsh's Nursery on the corner of Short and Thorn Streets, Ipswich Queensland (Times, 1891). A newspaper article in 1897 first mentioned Mr. Marsh's prize-winning 'Federator' strawberries (it is referred to in the article as 'Federation') in the Ipswich and West Moreton Agricultural and Horticultural Society's Spring Show (Times, 1897). Mr. James Pink (see 'Pink's Prolific') believed that William Marsh's 'Federator' resulted from a cross between 'Hudson's Bay' (female parent) and 'La Marguerite' and that 'La Marguerite' was of French origin (Pink, 1900).

However an article by the the originator of 'Phenomenal', Mr. Charles Flay, states that 'Federator', also known as 'Richard Gilbert'

in France, is of French origin (Flay, 1929). This contrasts with the newspaper article of Mr. James Pink (Pink, 1900). Nevertheless both Mr. Pink and Mr. Flay imply a French connection in the ancestry of 'Federator'.

Descendants of 'Phenomenal'.

'Phenomenal' is in the ancestry of 'Majestic', 'Redlands Crimson', 'Earlisweet' and 'Kabarla', which were also significant cultivars in Queensland until the late 1990's (Fig.3).

'Majestic' was bred in Palmwoods, Queensland by Mr. E. Mazarz in about 1955 (King 1959). One parent was 'Phenomenal' while the other was 'a local type' (selection) called 'Mitchell's Seedling' (Fig. 3). 'Majestic' is a vigorous plant with larger, firmer and darker red fruit than 'Phenomenal' (King, 1959) and produces higher yields (Darrow, 1966).

'Redlands Crimson' was bred at the Queensland Government's Redlands Horticultural Research Station (now Redlands Research Facility), Ormiston, Queensland (Greber, 1979) from a cross (Fig. 2) between 'Missionary' (Darrow, 1966) and 'Majestic' in about 1965, with first commercial plantings of virus-tested material available in 1968 (AnnRptDPI, 1969). By 1970 'Redlands Crimson' was the principal cultivar grown in Queensland (Officers of Horticulture Branch, 1970).

The original provisional release of 'Redlands Crimson' actually comprised two similar clones 'M7' and 'M9', but this release was subject to severe degradation by virus in the first season in the field (Greber, 1979). Subsequent testing showed each of the clones contained components of a severe yellow edge disease being Strawberry Mottle Virus (SMoV) in 'M9' and Strawberry Mild Yellow Edge Virus (SMYEV) in 'M7', and both selections according to Greber (1979) contained Tobacco Streak Virus (TSV). It was thought that combining the components to produce the severe disease was due to aphid vector activity of *Aphis*

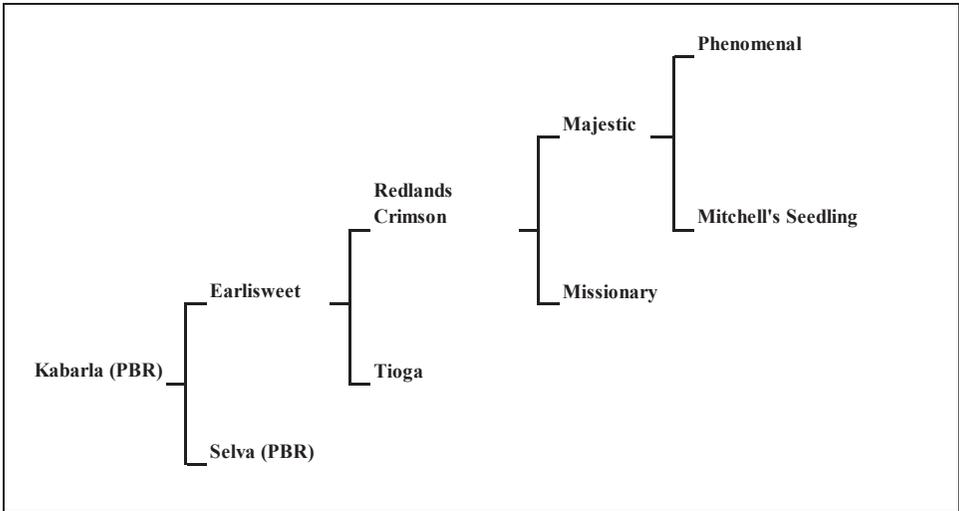


Fig. 3. Descendants of 'Phenomenal' through to 'Kabarla'.

gossypii (Greber, 1979). Following heat treatment which removed TSV, and tissue culture which removed SMYEV (Drew et al., 1986), 'M7' was chosen as the clone to subsequently represent 'Redlands Crimson' in commercial production. Sharman et al. (2011) later identified the TSV isolate from strawberry 'Redlands Crimson' in Australia as the more recently described Strawberry Necrotic Shock Virus (SNSV).

Interestingly, Greber (1979) reported that with vector control and after implementation of a clean plant runner scheme, virus incidence had dropped substantially in commercial fields, but that at the same earlier time 9 of 16 plants in the breeding field population were virus infected. Greber (1979) also reported that virus incidence in the breeding field in 1979 had also been reduced.

'Earlisweet' was bred by Mr. I. Bonner, Redlands Horticultural Research Station, Ormiston in 1969 from a cross between 'Redlands Crimson' and 'Tioga' (from California), and runners from virus-free foundation plants were released commercially by Queensland Department of Primary Industries (now Department of Agriculture and Fisheries) in March 1975

(Sullivan, 1974). Both early and total yield from 'Earlisweet' were higher with the fruit being sweeter, more uniformly colored and more uniformly distributed over the season than those of 'Redlands Crimson' (Sullivan, 1974).

'Kabarla' is an early-producing cultivar described in 1995 (Herrington, 1995) and originated from a cross between 'Earlisweet' and 'Selva' made in 1989 and first selected in 1990. 'Maroochy Flame' and 'Maroochy Starfire' (Herrington et al., 1999a;1999b, respectively) were produced from a cross between 'Kabarla' and 'Chandler' and provide the link between 'Phenomenal' and the recent and important releases of 'Red Rhapsody' in Queensland (Herrington and Woolcock, 2014) and 'Florida Beauty' in Florida (Whitaker et al., 2017).

Conclusion

'Phenomenal' was a significant cultivar in subtropical Queensland during the mid 1900's. A century after its development, this historically important strawberry is being used in research. The documentation presented in this study provides valuable information to enhance the use of pedigree

analysis in current strawberry breeding programs.

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About The Cover:

'Kent' mango is a seedling of 'Brooks' planted in 1932 at the property of Mr. Leith D. Kent, Coconut Grove, Fl. The tree first fruited in 1938 and was named and described in 1945. 'Kent' trees are vigorous, large, and compact, with upright canopies. 'Kent' is a late season cultivar with excellent eating quality and little fiber, so it was popular in Florida. However, because of its poor storage characteristics, production is limited in Florida, but it is still an important cultivar in Brazil. 'Kent' is the parent of several Florida mangoes. Photo provided by Ítalo Cavalcante.