

Metabolic Profiling of Rubus

Derek Stewart



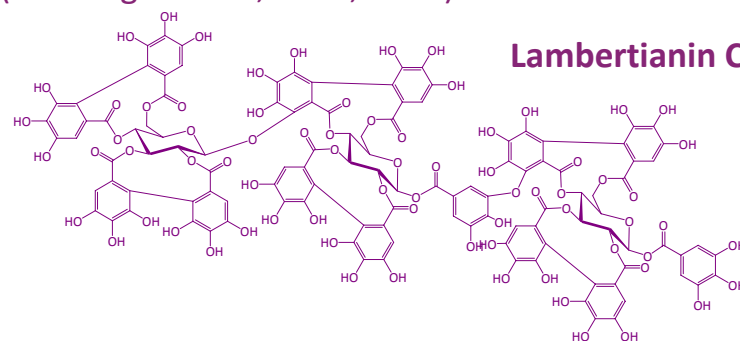


The James
Hutton
Institute

Introduction

Berries are among the richest sources of polyphenols in commonly eaten fruits

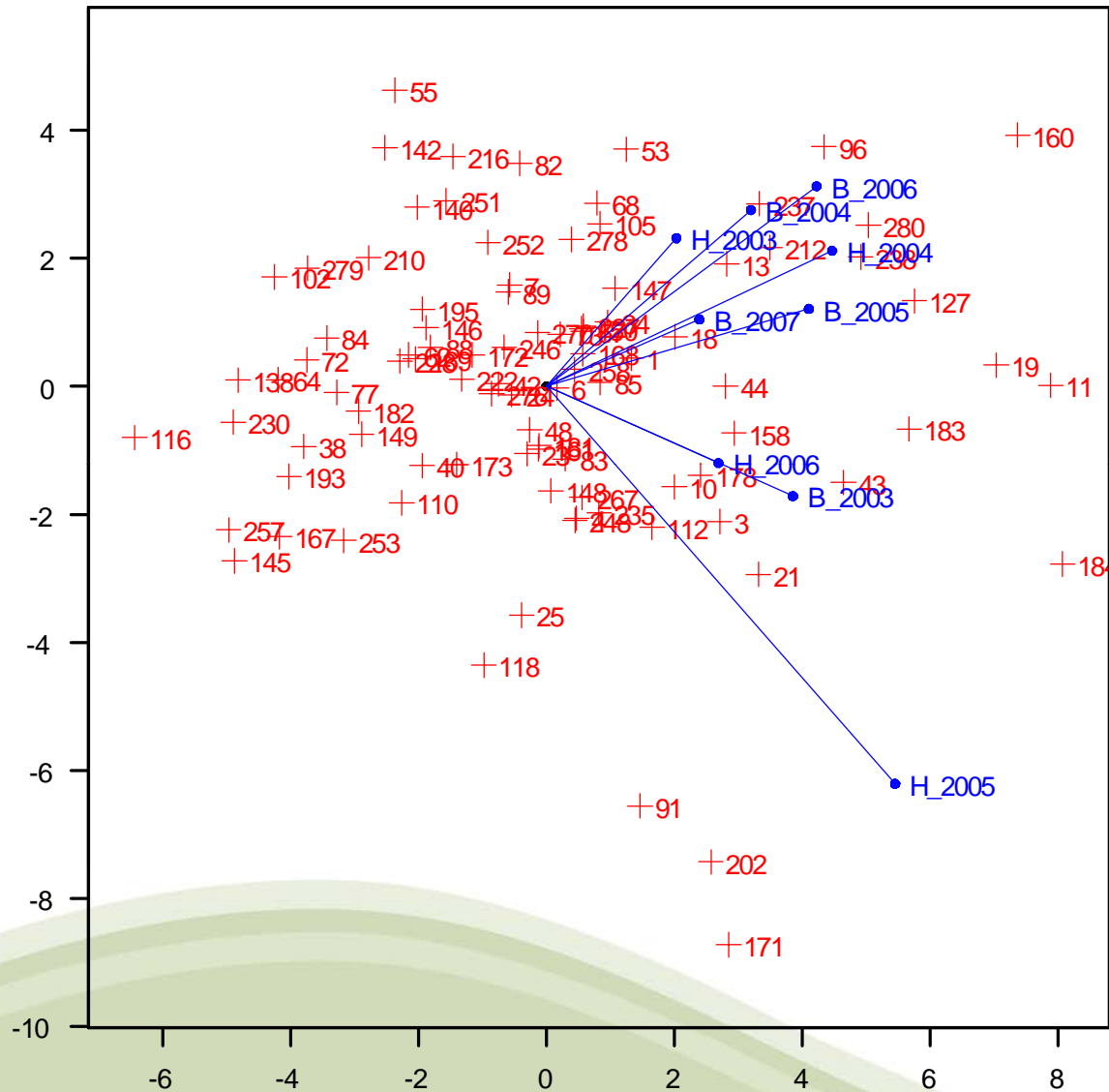
- Diverse range of polyphenols including flavonoids, such as anthocyanins, flavonols and flavanols, condensed and hydrolysable tannins and phenolic acid derivatives.
- Raspberries - anthocyanins and ellagitannins.
- Anthocyanins - Important targets for breeding efforts to improve and/maintain consumer quality perception.
- Raspberry polyphenols have been implicated in a range of bioactivities ;
- Potent inhibition of cancer cell lines (Ross et al., 2007; McDougall et al, 2008; Coates et al, 2007)
- Inhibition of digestive enzymes relevant to glycaemic control (McDougall et al., 2005, 2011)
- Lipid digestion and obesity (McDougall et al., 2009)



Expt. 1

- Cross between two *Rubus* sub-species, *Rubus ideaus* (cv. Glen Moy) and *Rubus strigosus* (cv. Latham)
- 4/5 seasons, 2 environments (\pm root rot: H & B field)
- Analyzed gross and specific polyphenol content.
- Aim was to establish metabolic-QTL (mQTL)

Diagnostic Biplot

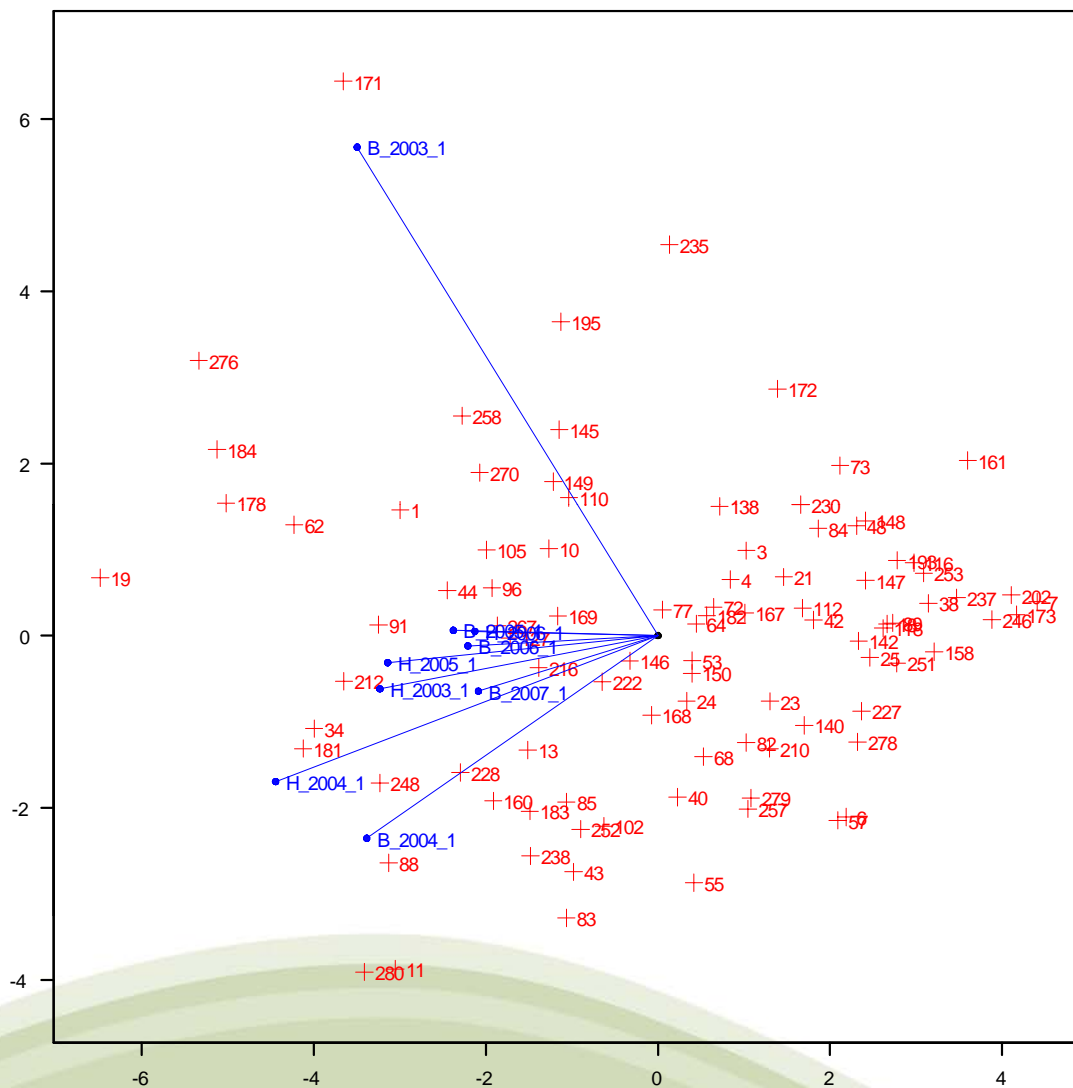


- Diagnostic biplot of total phenol content of progeny over different seasons.
- Generally the same progeny produce the higher levels
- The exception is in 2005 where lines 171, 202 and 91 gave the highest values.
- Possibly these are climate/environment sensitive at least with respect to TP.



The James
Hutton
Institute

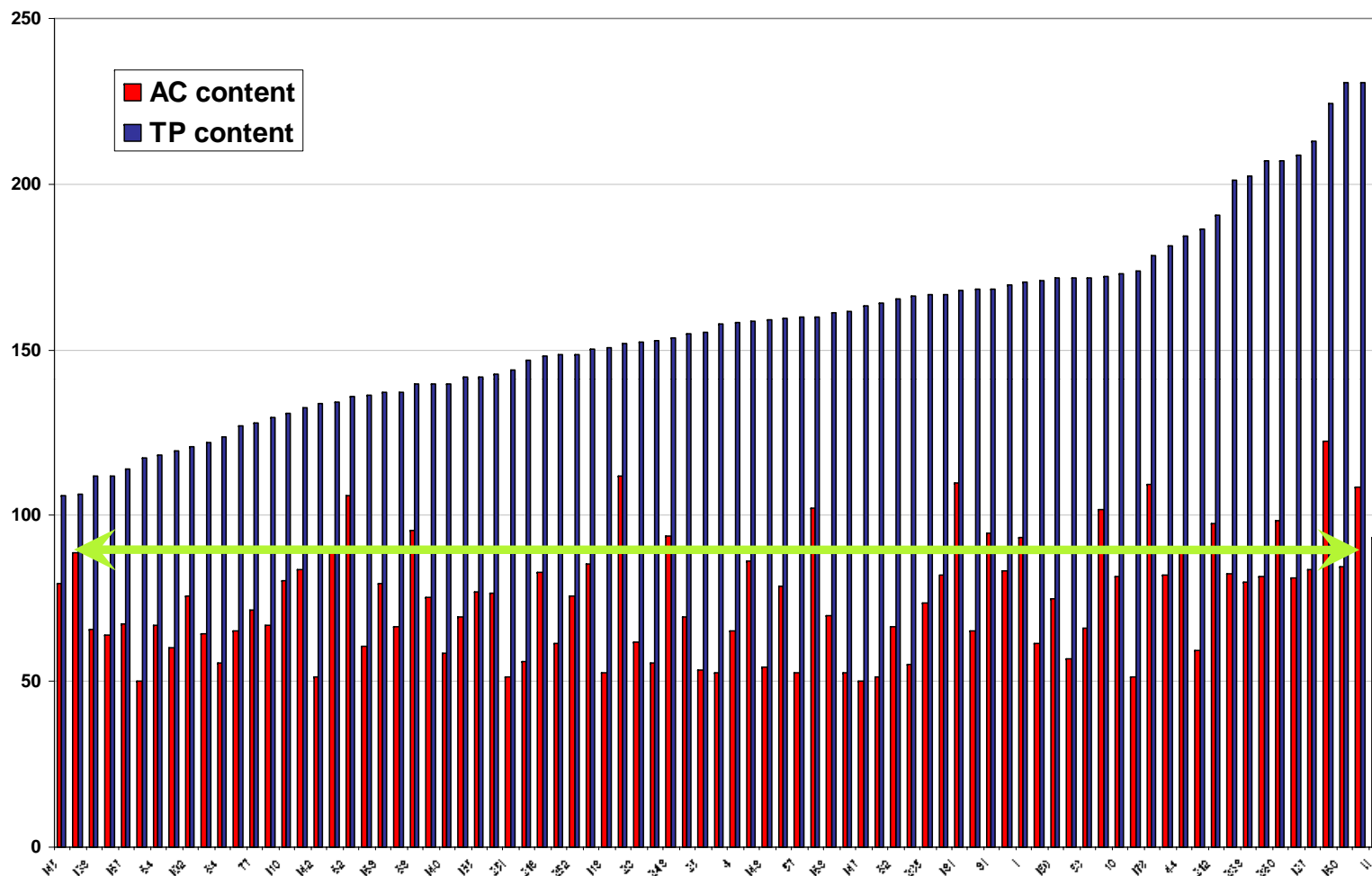
Diagnostic Biplot



- Diagnostic biplot of total anthocyanin content of progeny over 4 years
- Generally the same progeny produce the higher levels
- The exception this time is 2003 where line 171 gave the highest values.
- Possibly these are climate/environment sensitive at least with respect to TP.

Anthocyanin Content

Average total anthocyanin and total phenol contents for all progeny; (1 environment, 1 year)



- The genetic influence on TPC was illustrated by diagnostic biplots that showed that certain progeny tended to have high TPC in all growing seasons and under different field conditions.
- Similarly, certain progeny also showed high TAC across different seasons and different field conditions indicating a strong genetic element.
- However, other progeny only showed high levels of TPC and/or TAC in certain field conditions in certain years which suggested that these progeny may respond more readily to environment conditions (such as rainfall) prevalent in those seasons/locales
- For TAC, preliminary QTLs were identified – match previous efforts.
- This research confirms that these QTLs are robust over 5 different seasons at different field sites.
- For TPC QTLs were also identified some of which collocate (are the same as?) those for TAC
- The QTL areas that influence TPC but not TAC are of particular interest to boost general antioxidant capacity (bioactivity?) of raspberry fruits, which is generally correlated to TPC, and will be the focus of further studies.

Expt 2 (Part of cofunding experiment)

Analysis to look at the influence of parent gender of on fruit quality

Fathers: Graminor breeding lines N 94-29-24 & N 91-42-3

Mothers: Graminor breeding lines and industry standards

(+ comparators Asker and Vetem)



The James
Hutton
Institute



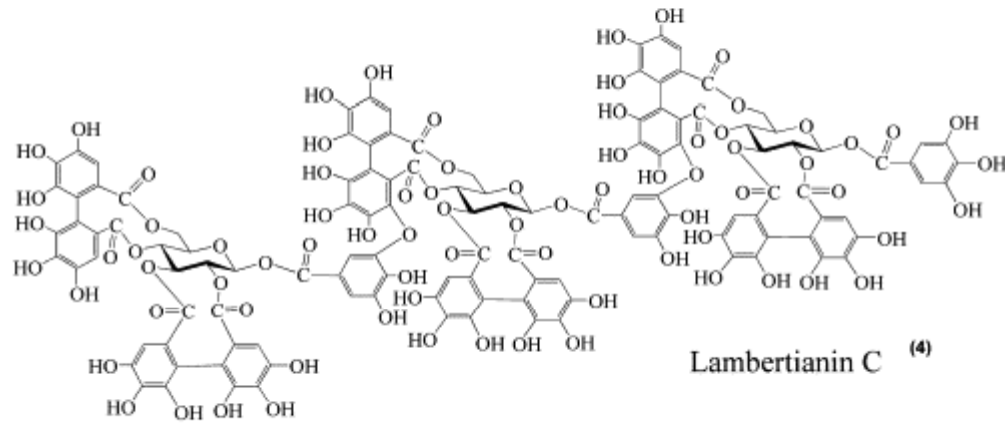
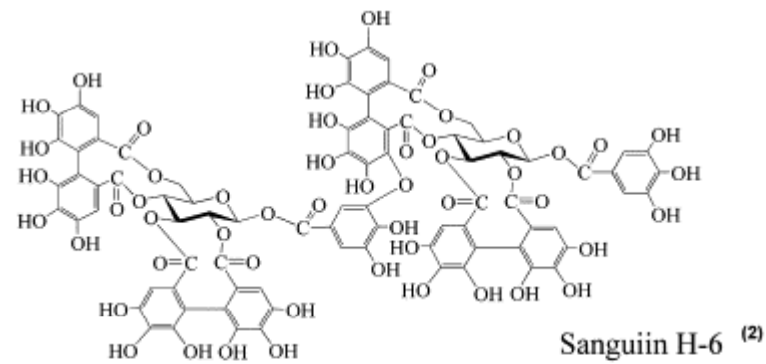
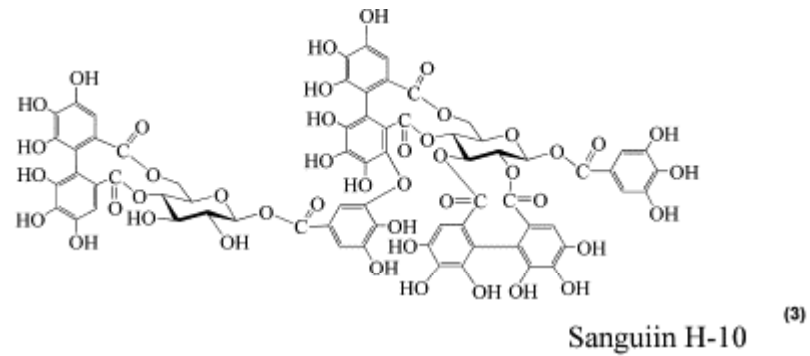
Graminor



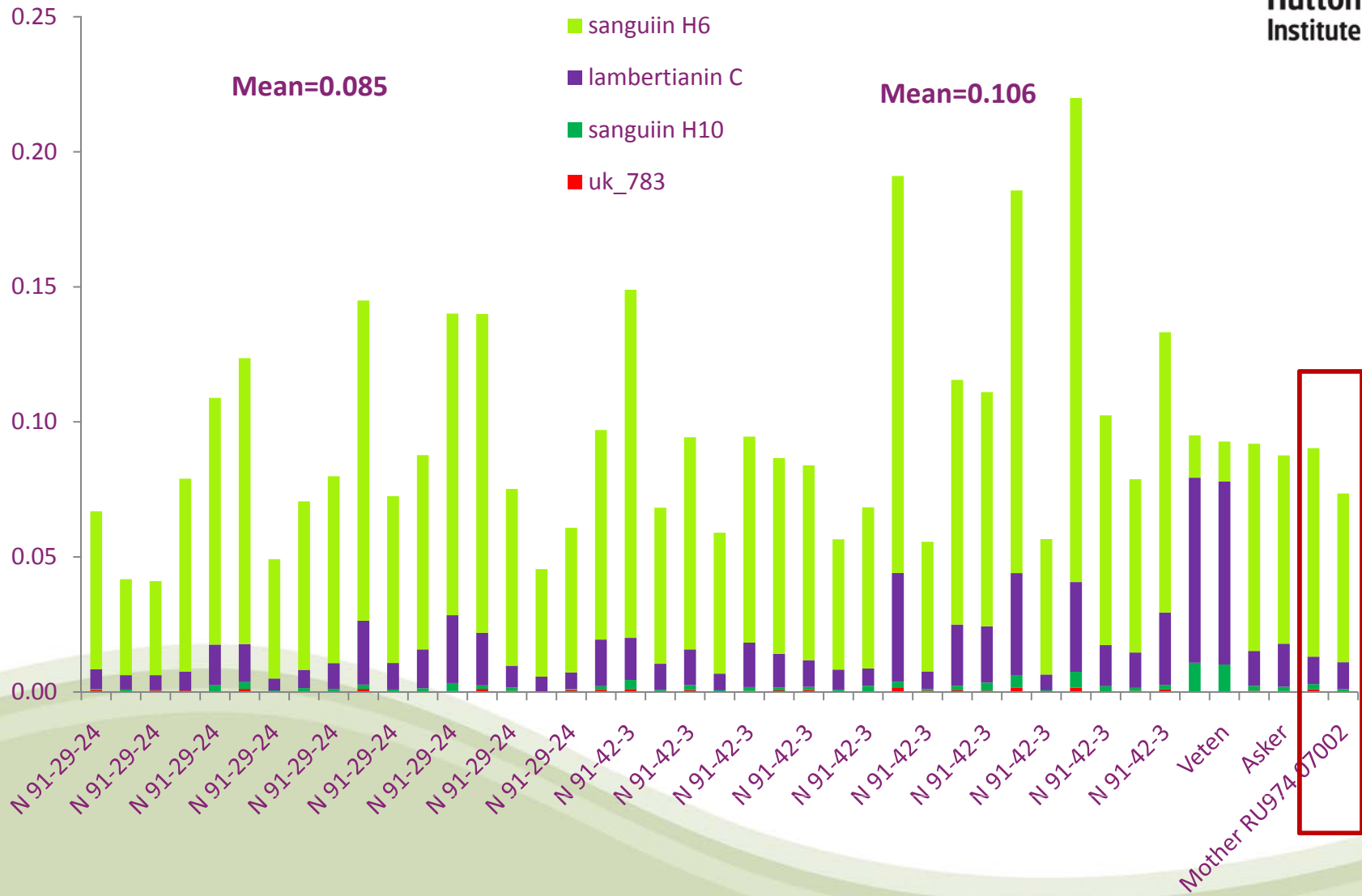
Father	N 94-29-24	N 91-42-3
Mother		
<i>Anthocyanins</i>		
RU974 07002		
Glen Ample		
Tulameen		
<i>Ellagitannins</i>		
RU974 07002		
Glen Ample		
Tulameen		



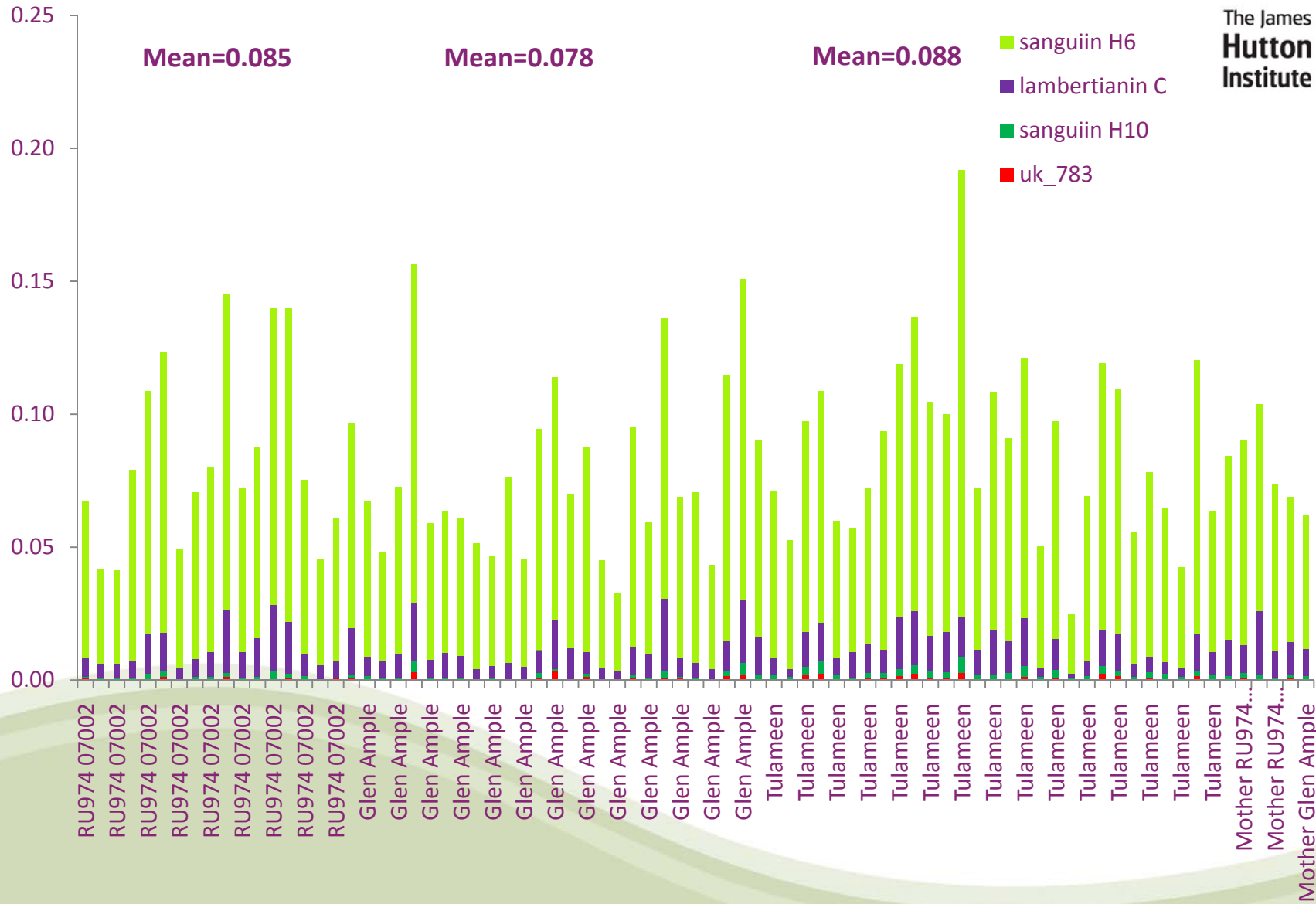
Prevalent ellagitannins in raspberry



Ellagitannin levels: RU974 07002 as mother



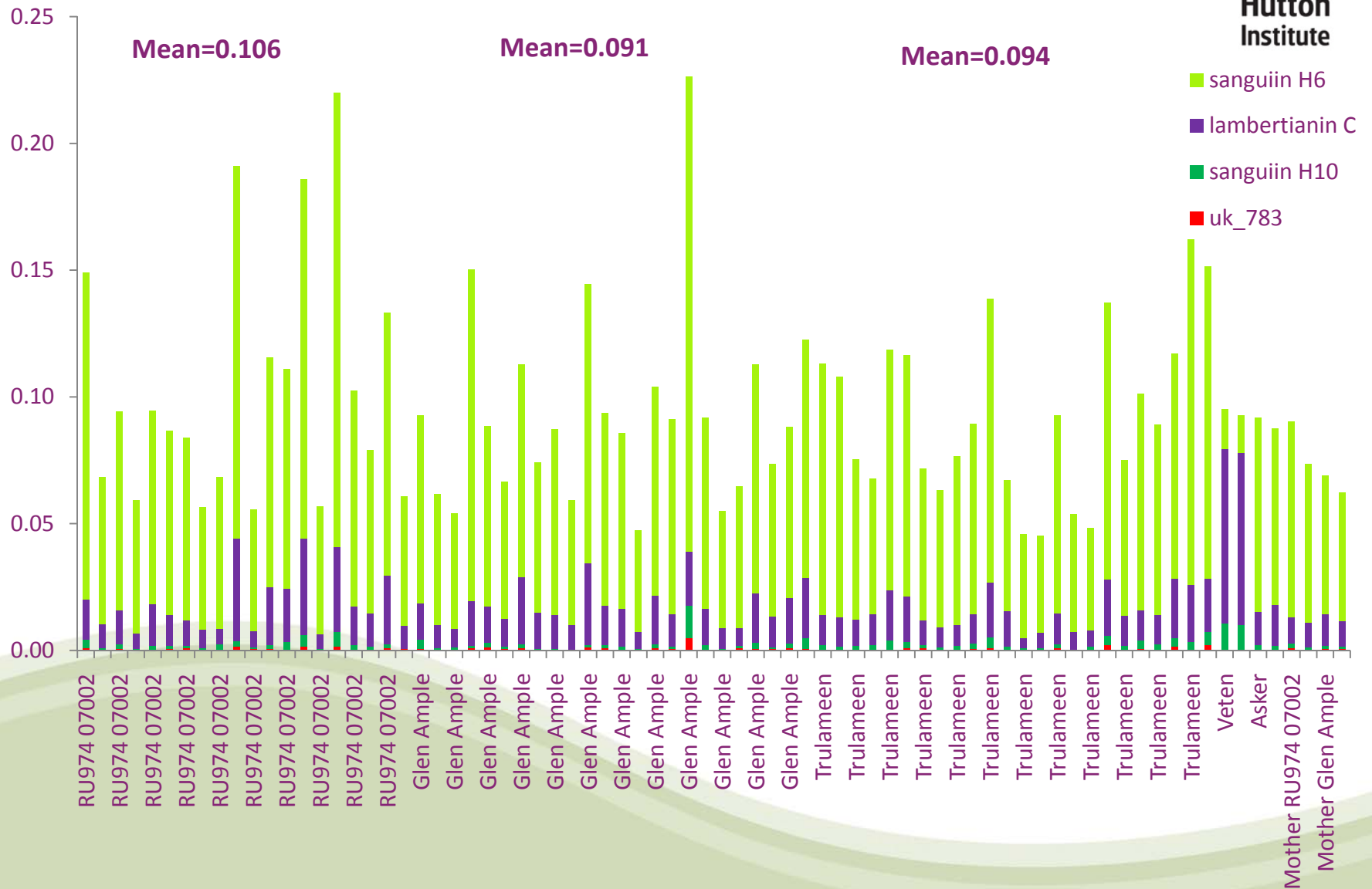
Ellagitannin levels: N 91-29-24 as father



Ellagitannin levels: N 91-42-3 as father



The James
Hutton
Institute



Conclusions

- Even in this limited set of crosses polyphenol diversity is significant.
- C-Soph, C-R and C-G-R are the dominant anthocyanins but their relative proportions vary considerably.
- N 91-29-24 (M) x RU974 07002 (F) yielded the best mean anthocyanin contents (0.454 mg/ml). However some of the progeny (*) were completely deficient in C-G-R.
- Sanguin H6 and Lambertianin C were the dominant ellagitannins and the relative proportions of these varied significantly both within and across the crosses.
- All crosses with N91-42-3 as the father exhibited greater comparative (to N 91-29-24) mean ellagitannin levels.
- An as yet uncharacterized and minor ellagitannin was quantified (ellagic acid equivalents).
- All individual polyphenols were characterized and quantified for each line using a metabolomic approach . This yielded a significant reduction resource and man-time requirements and delivered highly detailed data that can very quickly be translated through to breeding programmes.