THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

QAAFI
Queensland Alliance for Agriculture & Food Innovation

Novel sources for quality:

Australian contributions to rice quality

Robert Henry

Working together with the Queensland Government

Queensland Government

Options for innovation

- Increased production- efficiency
- Increased product value- quality

Healthy populations

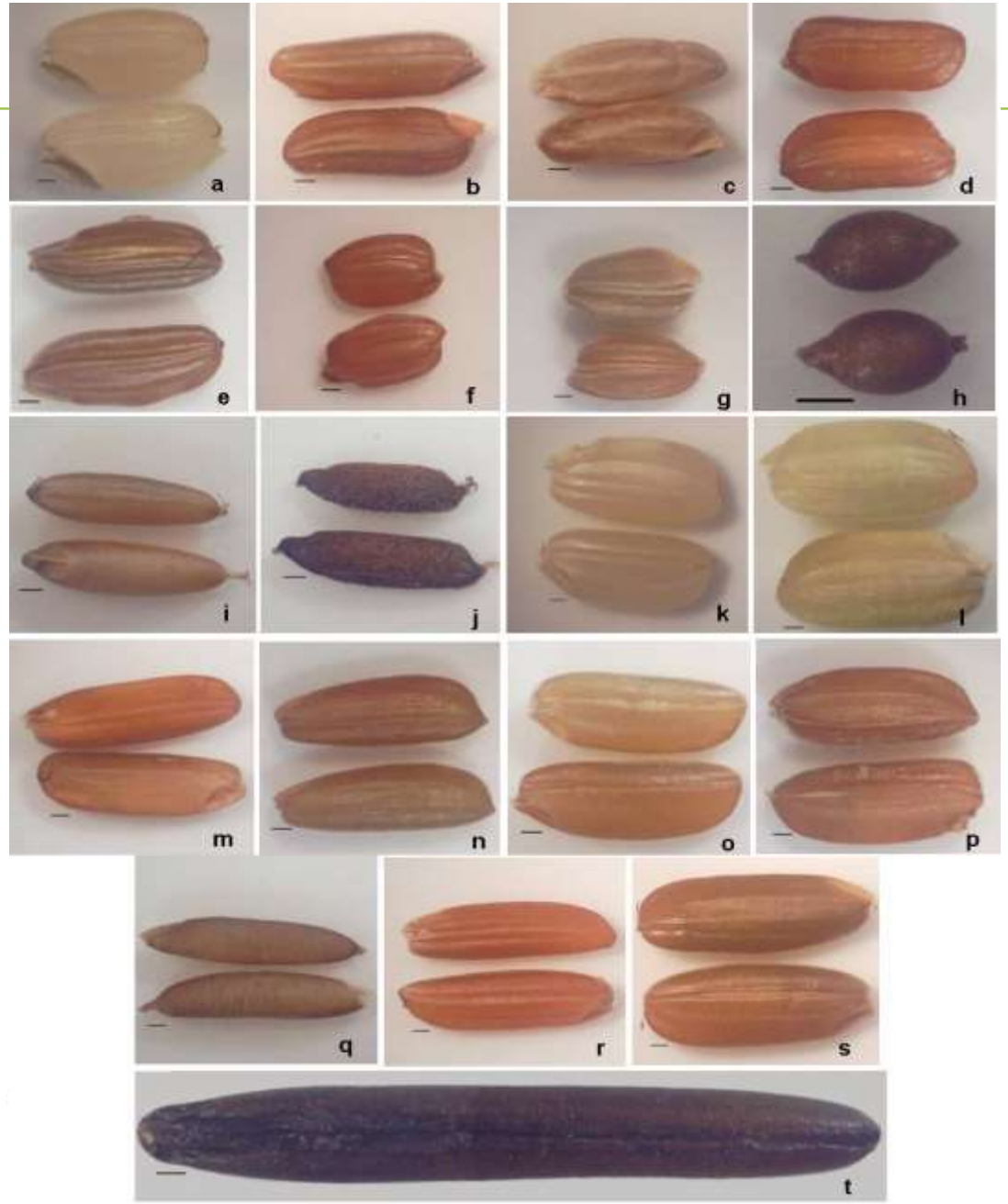
Blue-sky rice

- Rice is a staple food, but production is not keeping pace with the rise in global population. So scientists are dreaming big and aiming high to change the future for this crucial grain.

- LEIGH DAYTON

- S52 | NATURE | VOL 514 |
- 30 OCTOBER 2014

Rice wild relatives

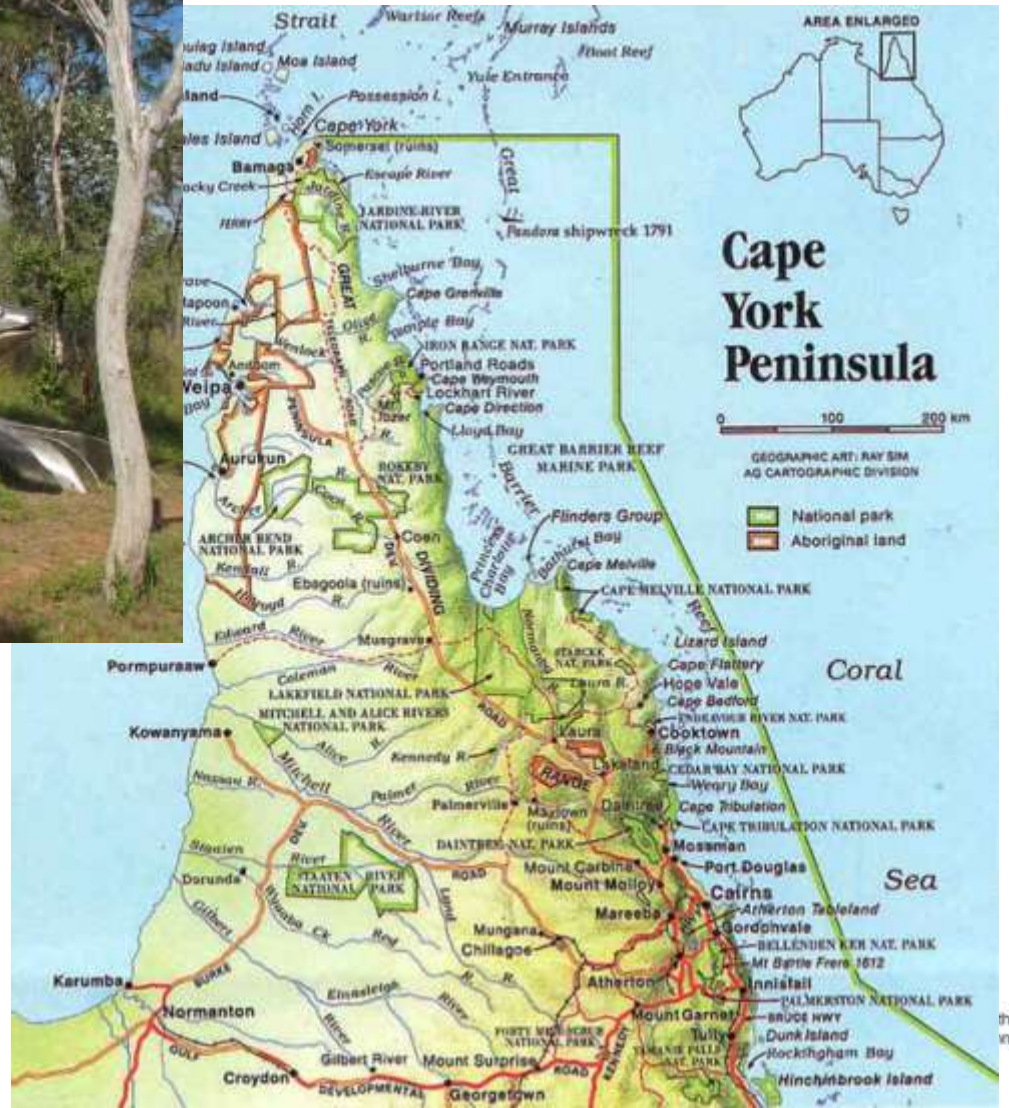


Kasem S, Waters DLE, Rice N, Shapter FM, Henry RJ (2010) Whole grain morphology of Australian rice species. Plant Genetic Resources 8:74-81.

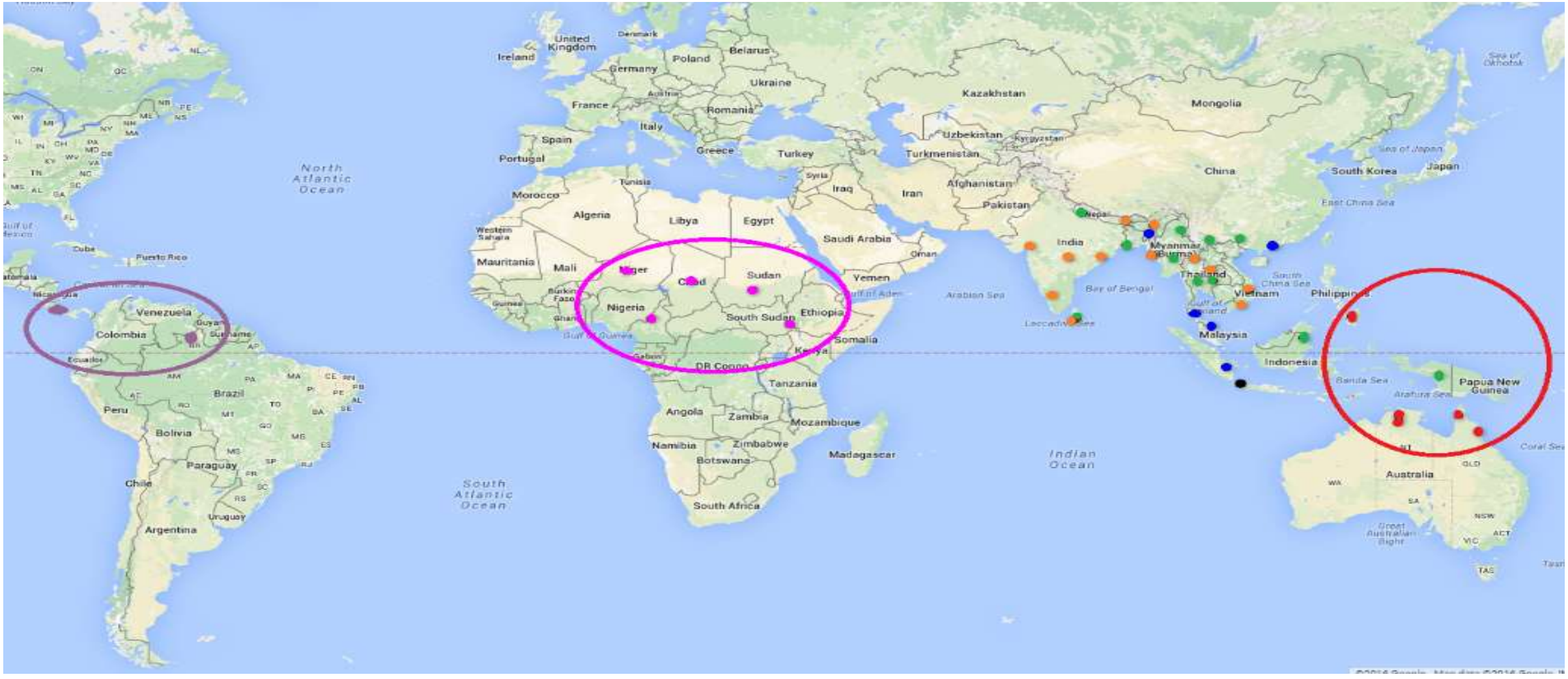
Kasem S, Waters DLE, Rice N, Shapter FM, and Henry RJ (2011) The endosperm morphology of rice and its wild relatives as observed by scanning electron microscopy. Rice 4: 12-13.

Diversity of Rice in Australia

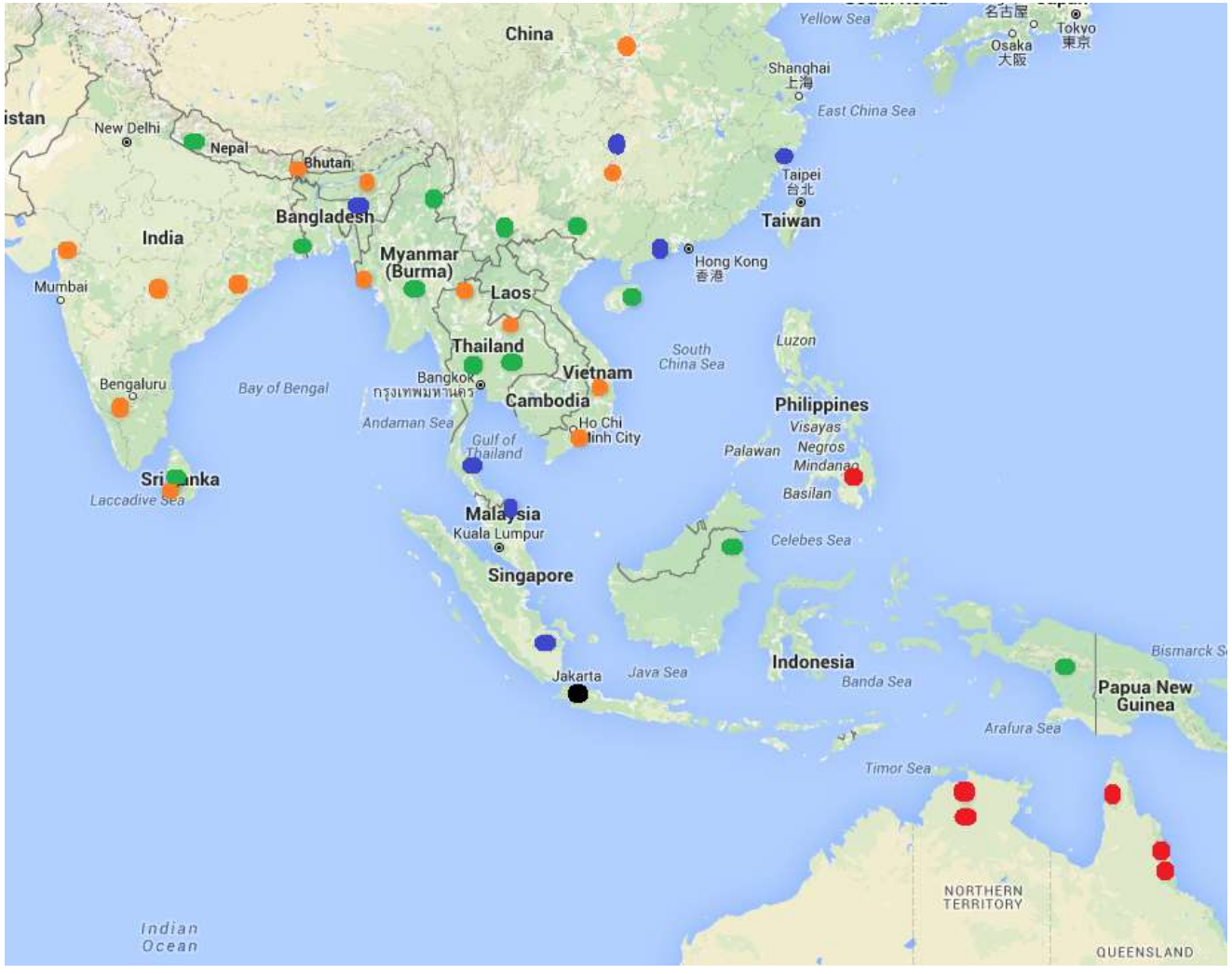
Current wild rice collection program



Wild relatives of rice



Ancestors of cultivated rice



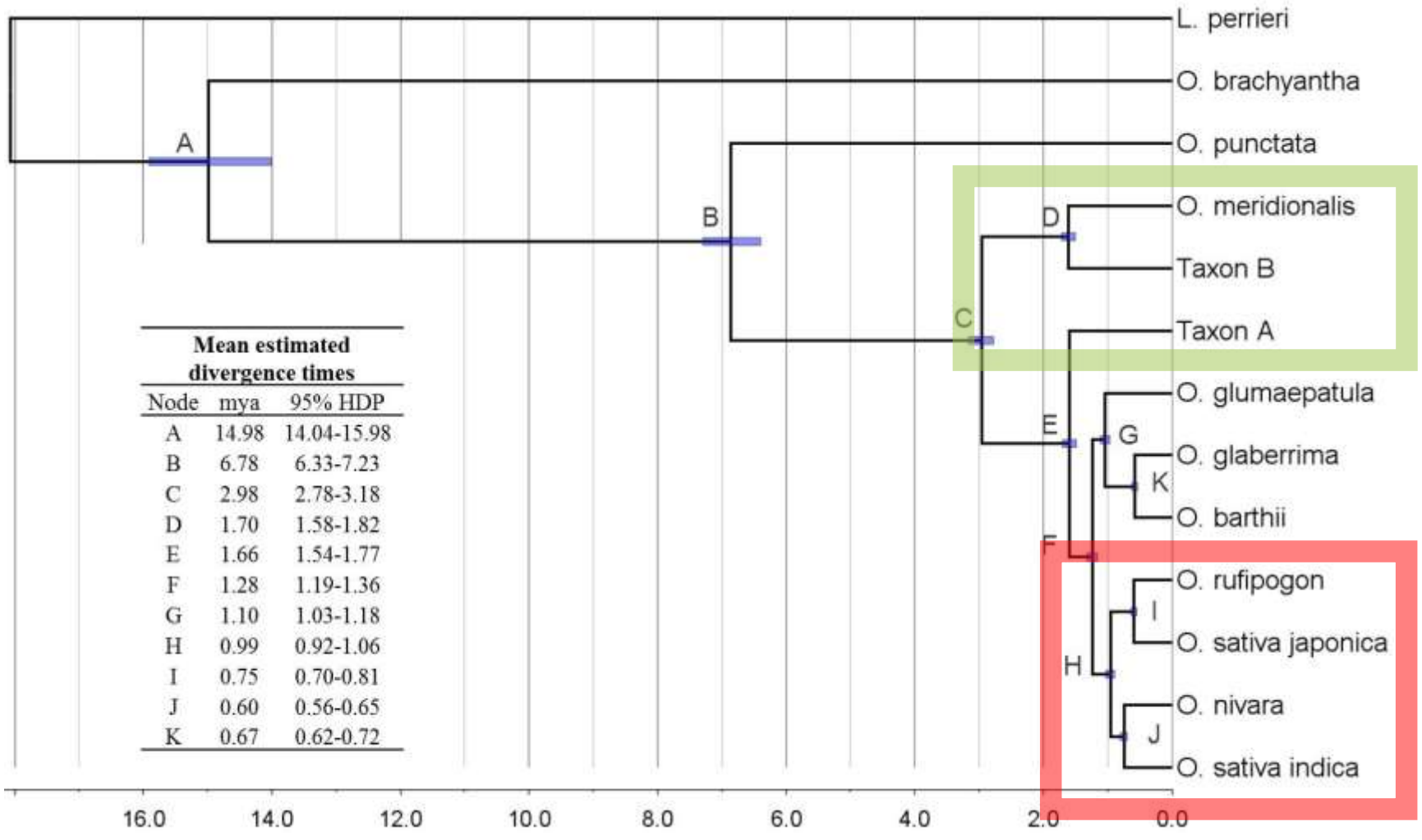
Species A

Species B

Taxon A and Taxon B in their natural habitat in Queensland (Mareeba Wetlands); Taxon A – open panicles, Taxon B – closed panicles.

Rice grains: A – Taxon A, B – Taxon B, C – *O. meridionalis*, D – *O. rufipogon*, E – *O. australiensis*.

Evolution of rice



Mean estimated divergence times

Node	mya	95% HDP
A	14.98	14.04-15.98
B	6.78	6.33-7.23
C	2.98	2.78-3.18
D	1.70	1.58-1.82
E	1.66	1.54-1.77
F	1.28	1.19-1.36
G	1.10	1.03-1.18
H	0.99	0.92-1.06
I	0.75	0.70-0.81
J	0.60	0.56-0.65
K	0.67	0.62-0.72

4000genes

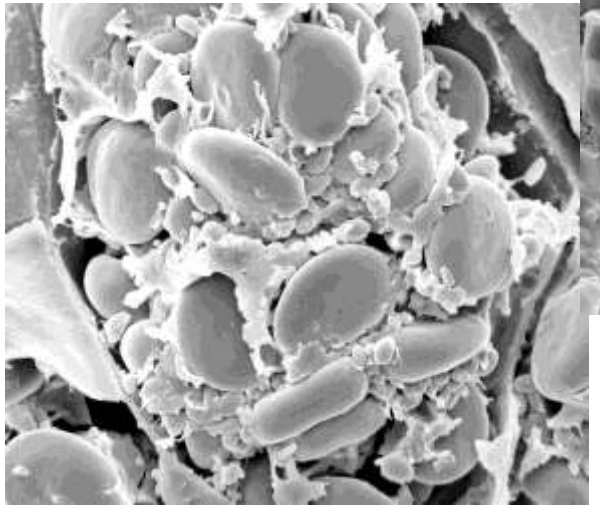
6 Mbp

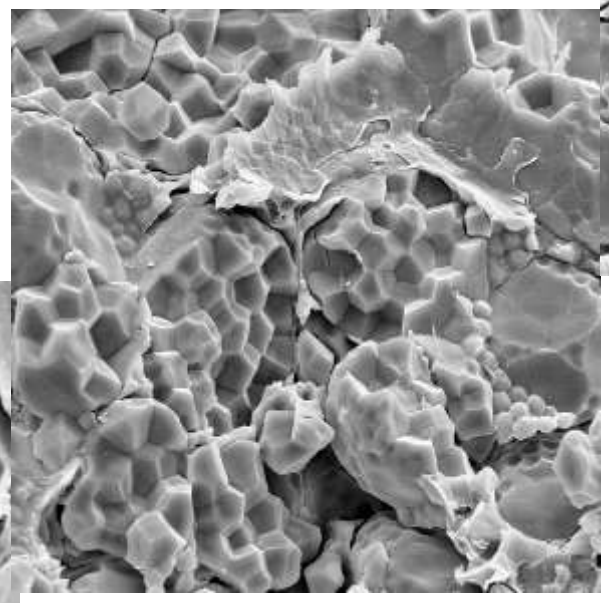
Large wild rice populations

Photo Marta Brozynska

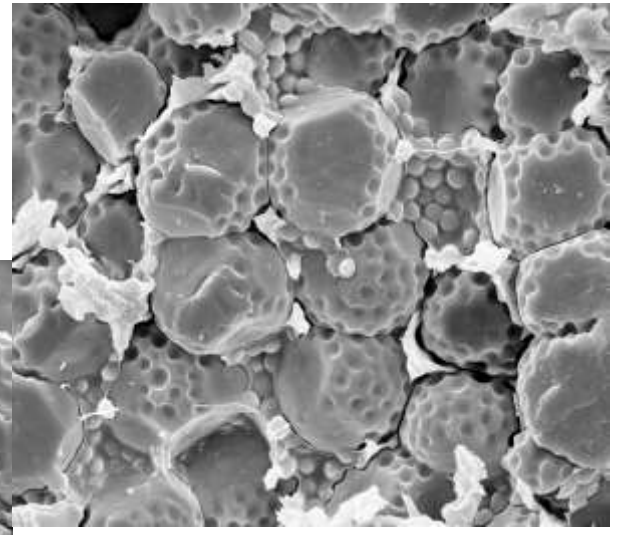
Cereal Starches

Wheat relative
A and B type Granules
A: <10µM
B: 10-50µM



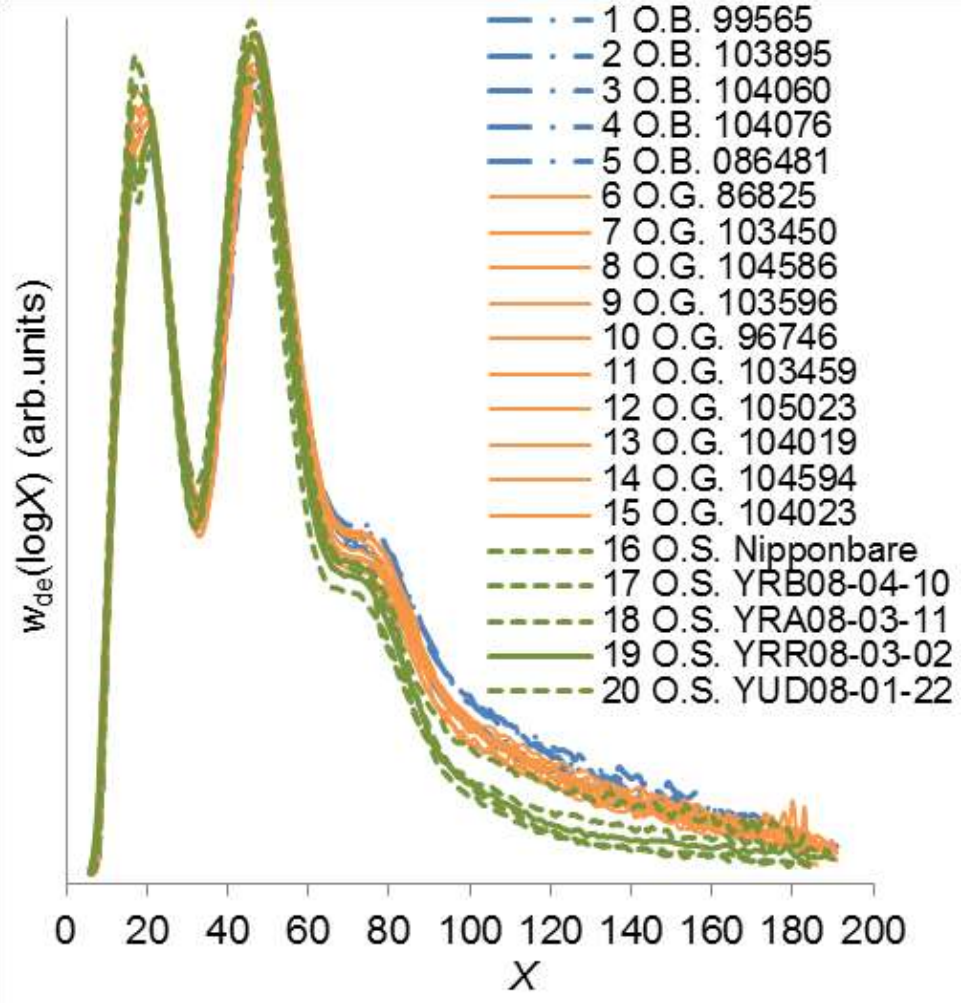


Rice like Granules
Rigid dodecahedrons
2-5µM
Compound granules



Sorghum granules
10-30µM
Spherical to
non-uniform polyhedral

Novel rice starch properties



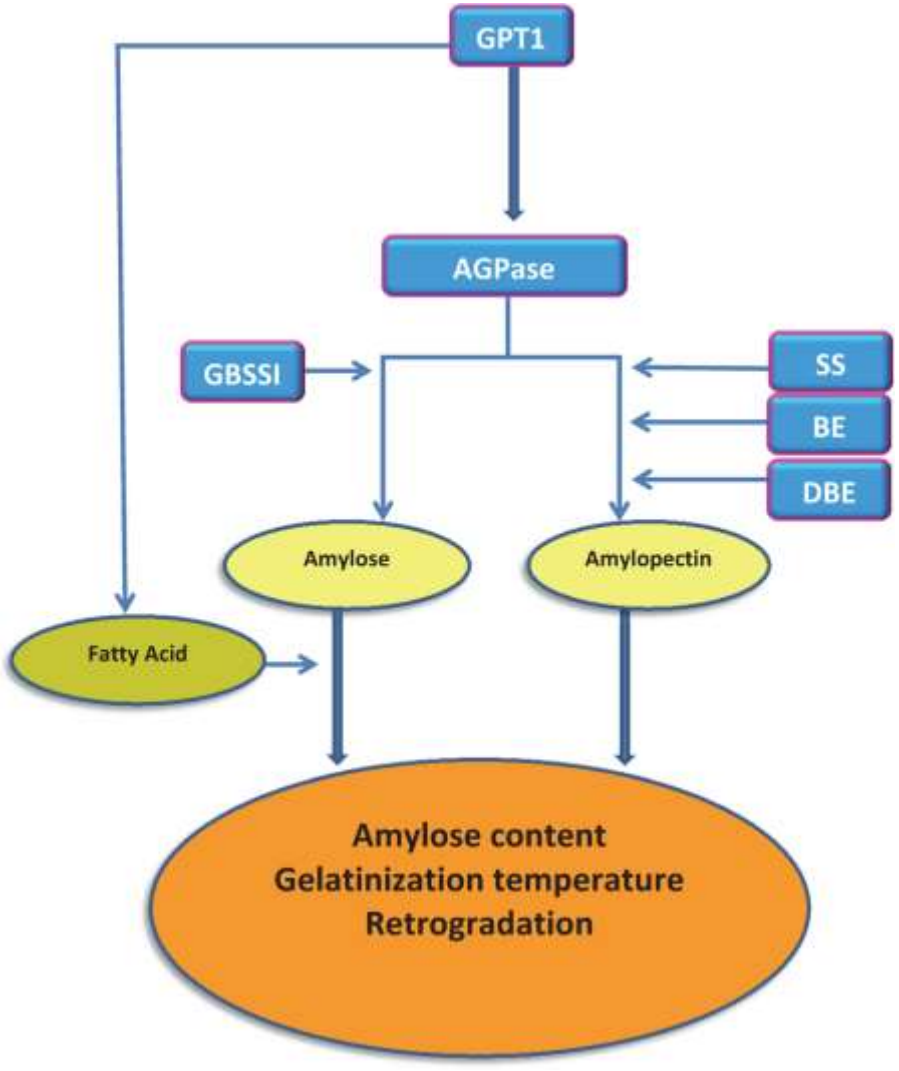
Wang K, Wambugu PW, Zhang B, Wu AC, Henry RJ and Gilbert RG (2015) The biosynthesis, structure and gelatinization properties of starches from wild and cultivated African rice species (Oryza barthii and Oryza glaberrima). Carbohydrate Polymers 129, 92-100.

Health Starch and Plant Genetics

Starch Properties

Starch Chemistry

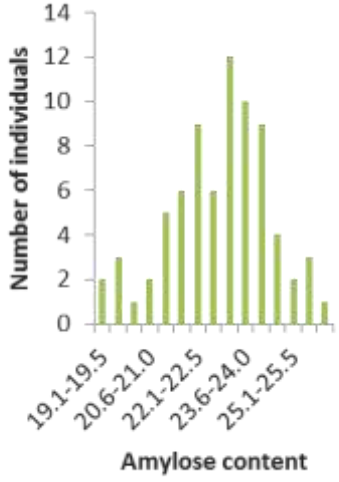
Starch Genetics

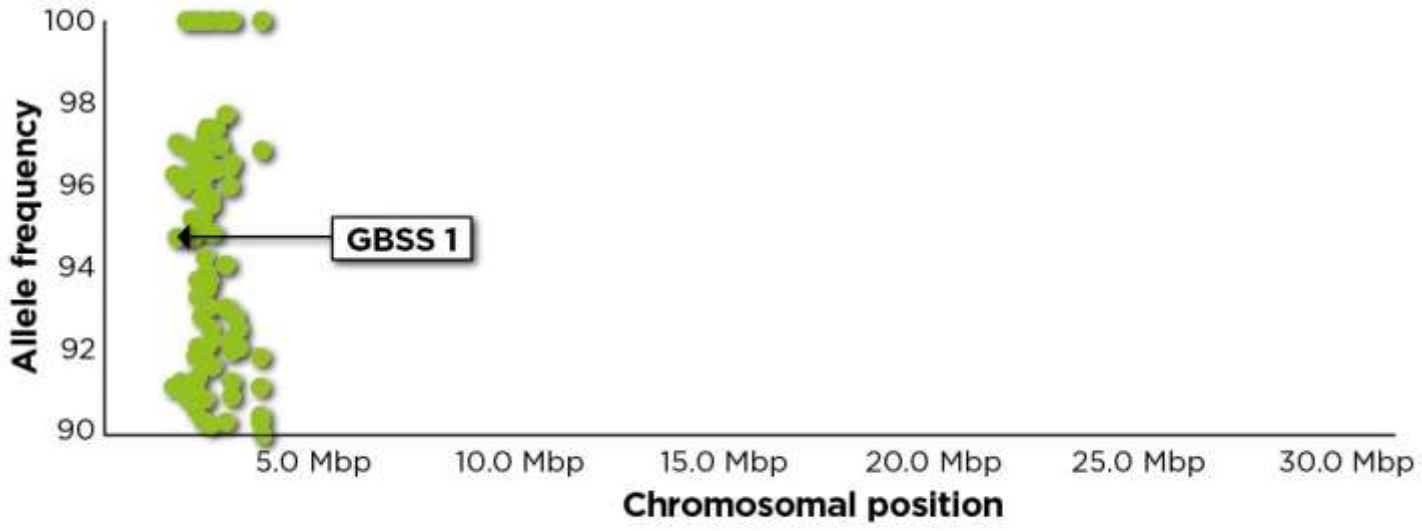


Kharabian-Masouleh, A, Waters, DLE, Reinke, RF, and Henry, RJ (2011) Discovery of polymorphisms in starch genes in rice germplasm by amplification of pooled DNA and deeply parallel sequencing. Plant Biotechnology Journal 9: 1074-1085.

Identification of genes controlling quality

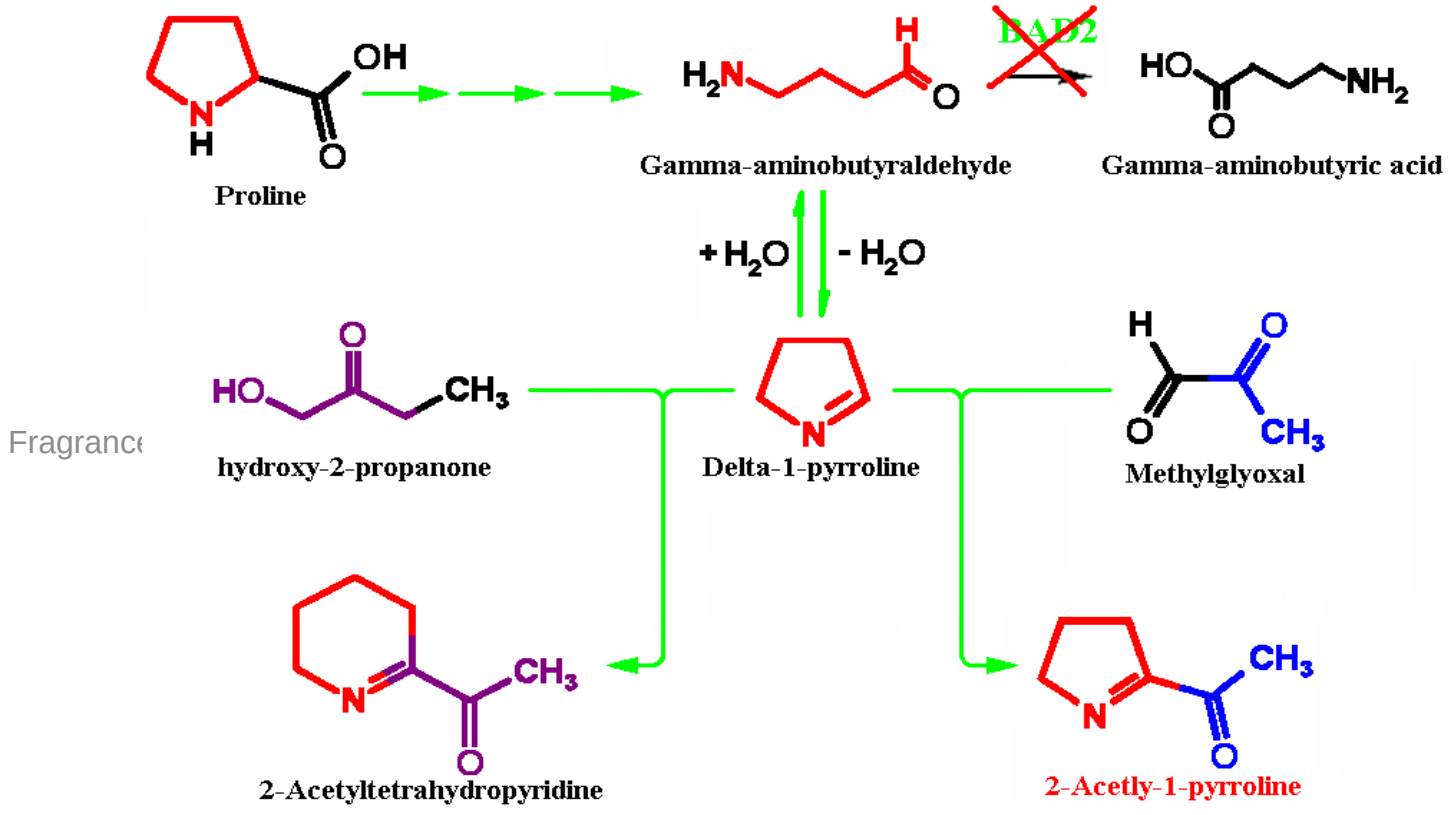
SNP associated with amylose content
O. glaberrima X O.sativa





Wambugu PW, Ndjiondop M-N, Furtado A, Henry RJ (2017) Sequencing of bulks of segregants allows dissection of genetic control of amylose content in rice. Plant Biotechnology Journal

Fragrance (sorghum and pandan genes)

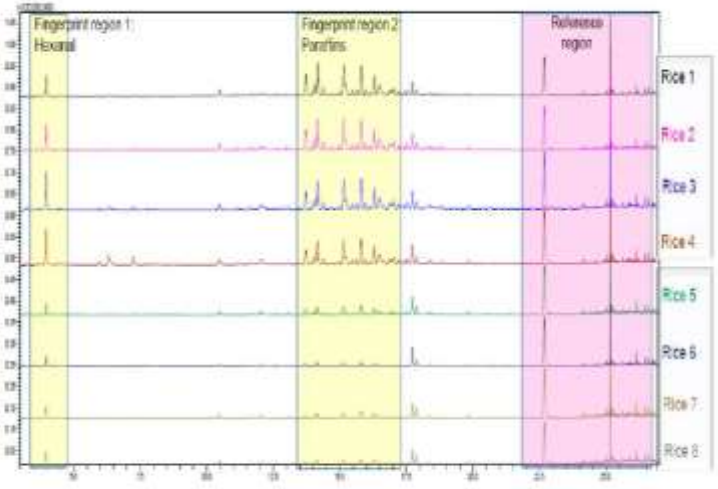


Fragrance

Bradbury LME, Gillies SA, Brushett D, Waters DLE, Henry RJ (2008) Inactivation of an aminoaldehyde dehydrogenase is responsible for fragrance in rice. Plant Molecular Biology 68: 439-449.

High value rice for discerning consumers

Anacleto R, Cuevas RP; Jimenez; R, Llorente C, Nissila E, Henry R, Sreenivasulu N (2015) Prospects of breeding high-quality rice in the post-genomic era. Theoretical and Applied Genetics 128 8: 1449-1466.

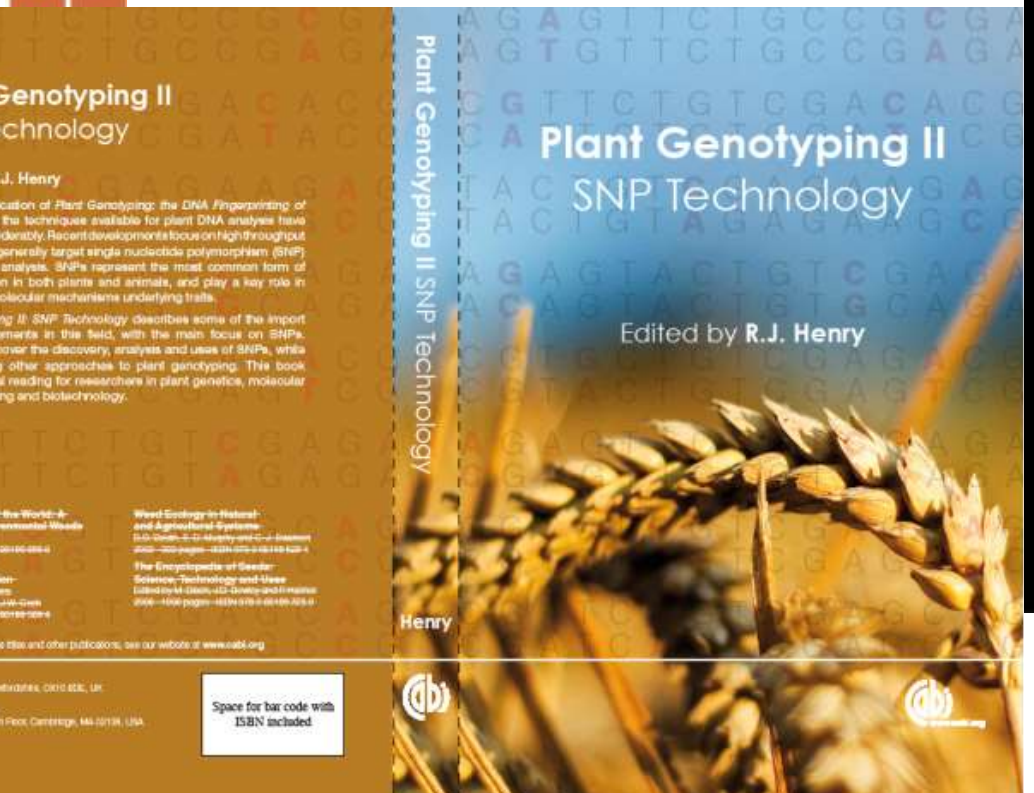


Information Technology

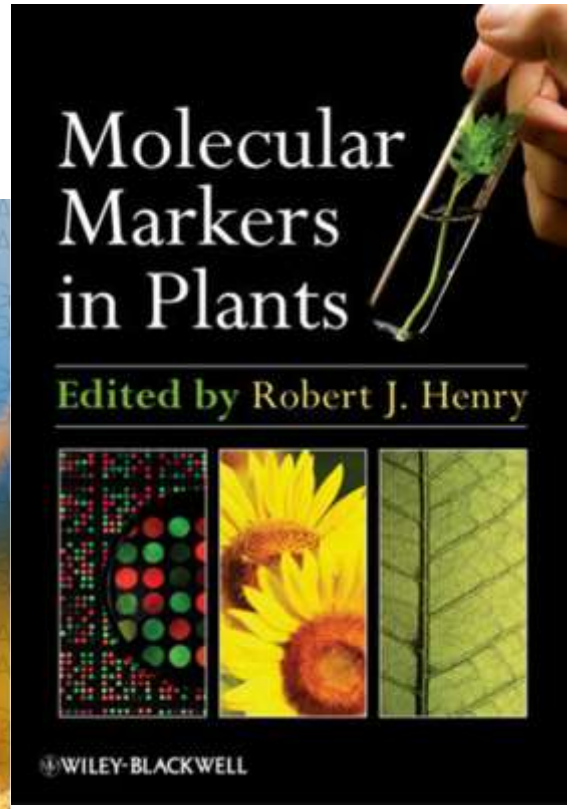
Rossetto M and Henry RJ (2014) Escape from the laboratory: new horizons for plant genetics. Trends in Plant Science

Genomics Technology

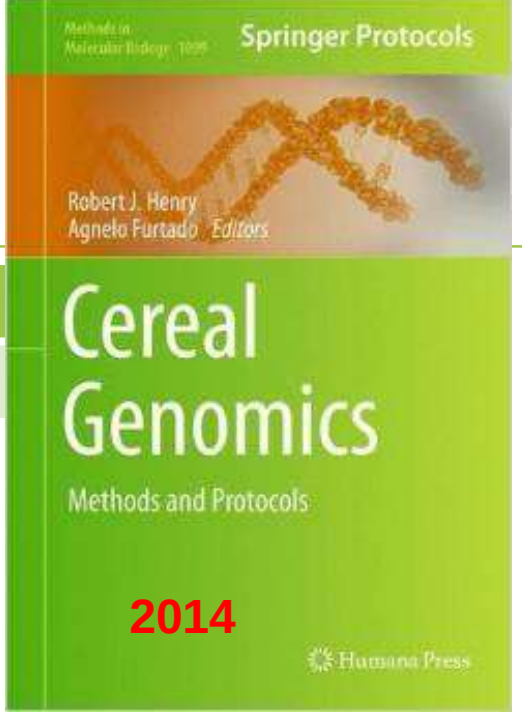
2008



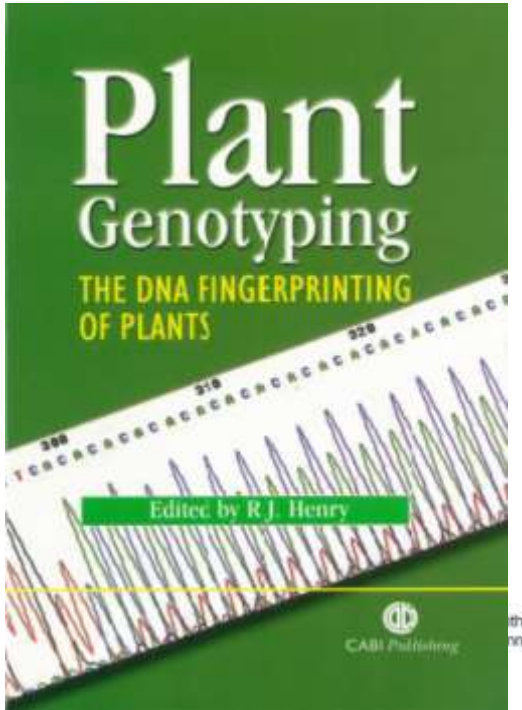
2013



2014

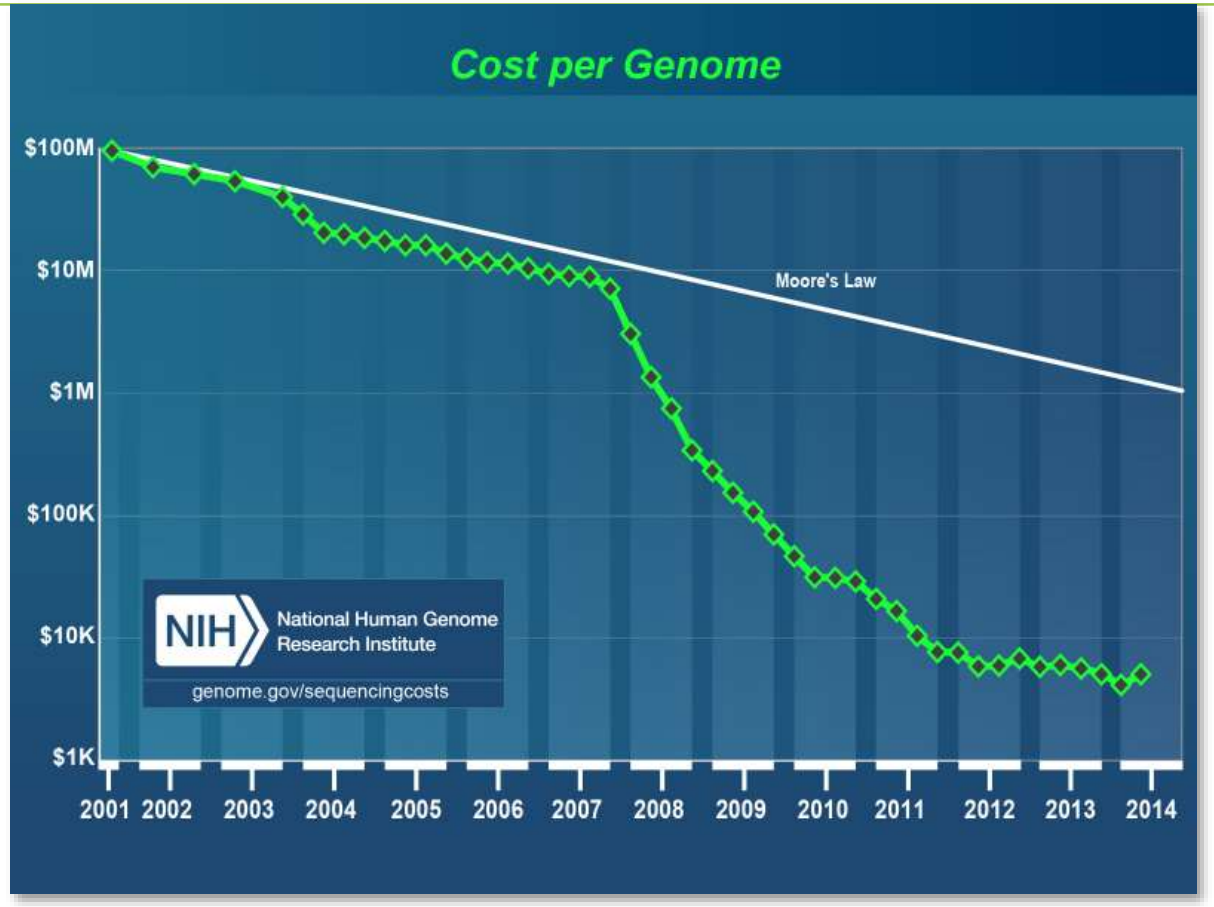


2001



Queensland Government

Soon it will cost **less** to sequence a genome than to flush a toilet



http://www.businessinsider.com.au/super-cheap-genome-sequencing-by-2020-2014-1
Ajai Raj, 3 Oct 2014

Gene editing

Photo: Porteus lab Stanford

Domestication of New Crops

Henry RJ (2012) Next generation sequencing for understanding and accelerating crop domestication. Briefings in Functional Genomics 11: 51-56.

Microlaena domestication

Shapter FM, Cross M, Ablett G, Malory S, Chivers IH, King GJ and Henry RJ (2013) High-throughput sequencing and mutagenesis to accelerate the domestication of *Microlaena stipoides* as a new food crop. PLOS ONE 8(12) e82641. doi:10.1371/journal.pone.0082641

International Climate-Resilient Crop Genomics Consortium (ICRCGC)

www.climatechangegenomics.org

Shapter FM, Fitzgerald TL, Waters DLE, McDonald S, Chivers IH, Henry RJ (2012) Analysis of adaptive ribosomal gene diversity in wild plant populations from contrasting climatic environments. Plant Signaling & Behavior 7: 1-3.

Mitigation versus adaption

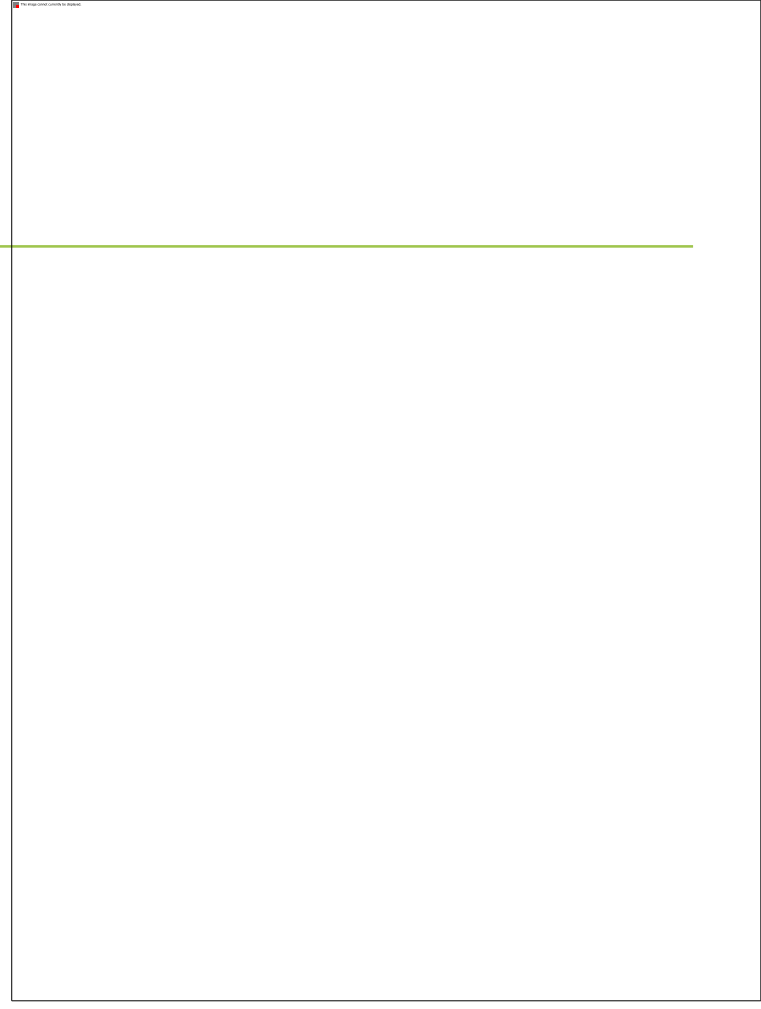
Henry RJ and Nevo E (2014) Exploring natural selection to guide breeding for agriculture. Plant Biotechnology Journal 12, 655-662.

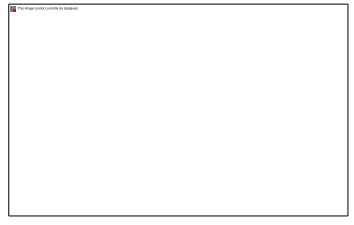
Agricultural Nanotechnology

Bioclay

Plant genetics

- Current genetic targets
  - Rice
  - Wheat
  - Coffee
  - Macadamia
  - Peanut
  - Mango
  - Kakadu Plum
  - Eucalypts
  - Sugarcane





CRC for

Distinctive Australian Foods

Growing premium brands

www.distinctive-australian-foods.com.au

The University Of Queensland AUSTRALIA | QAAFI Queensland Alliance for Agriculture & Food Innovation

Working together with the Queensland Government — Queensland Government

RESEARCH PROGRAMS

Established industries research

Emerging industries research

Future industries research

International Rice collaborations

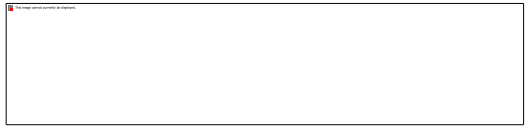
- Better Cereal Centre, College of Agriculture, Yangzhou University, Yangzhou 225009, Jiangsu Province, P.R.China
- Black/red rice program MOST, Vietnam
- Faculty of Agriculture and Life Science,Hirosaki University

  Hirosaki, Aomori 036-8561, Japan
- ICAR New Delhi
- University Pune
- IOMAP collaboration

Rossetto M and Henry RJ (2014) Escape from the laboratory: new horizons for plant genetics. Trends in Plant Science 19, 554-555.

Capturing biodiversity for food security

23-29 July 2017



Large wild rice populations

Photo Marta Brozynska