Collating *P. infestans* population data: an update

David Cooke, Poul Lassen, Jens G Hansen

Summary

- Background – key findings in past 18 months
- Recent data on European monitoring
- Status and plans for Eucablight database using rust toolbox as an example
- Conclusions and key questions

What is new since StPetersburg?

- 13_A2 spread in GB published

OPEN ACCESS Freely available online

PLOS | PATHOGENS

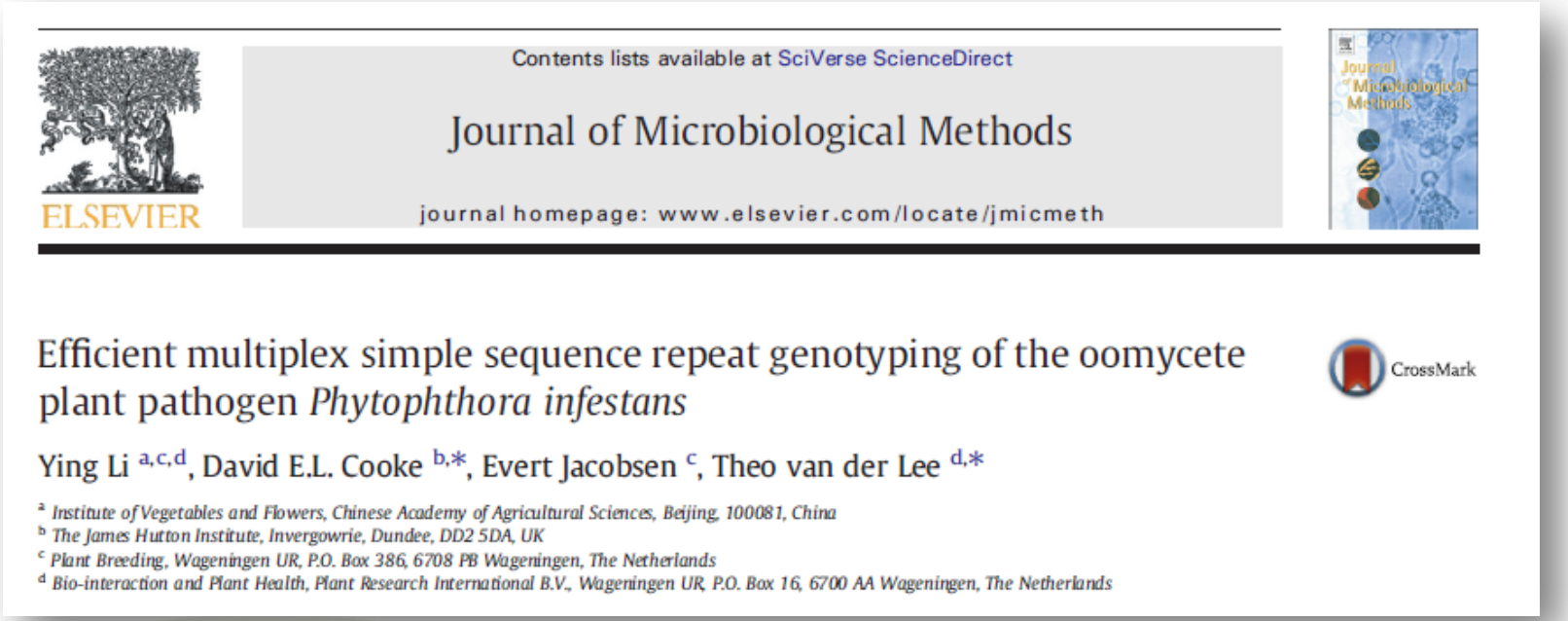
Genome Analyses of an Aggressive and Invasive Lineage of the Irish Potato Famine Pathogen

David E. L. Cooke[1]*, Liliana M. Cano[2], Sylvain Raffaele[2], Ruairidh A. Bain[3], Louise R. Cooke[4], Graham J. Etherington[2], Kenneth L. Deahl[5], Rhys A. Farrer[2], Eleanor M. Gilroy[1], Erica M. Goss[6,7], Niklaus J. Grünwald[6], Ingo Hein[1], Daniel MacLean[2], James W. McNicol[8], Eva Randall[1], Ricardo F. Oliva[2,9], Mathieu A. Pel[10], David S. Shaw[11], Julie N. Squires[1], Moray C. Taylor[12], Vivianne G. A. A. Vleeshouwers[10], Paul R. J. Birch[1,13], Alison K. Lees[1], Sophien Kamoun[2]*

1 The James Hutton Institute, Invergowrie, Dundee, United Kingdom, 2 The Sainsbury Laboratory, Norwich Research Park, Norwich, United Kingdom, 3 SAC, Edinburgh, United Kingdom, 4 Agri-Food and Biosciences Institute, Belfast, United Kingdom, 5 USDA-ARS/PSI-GIFVL, BARC-West, Beltsville, Maryland, United States of America, 6 Horticultural Crops Research Laboratory, USDA ARS, Corvallis, Oregon, United States of America, 7 Emerging Pathogens Institute & Department of Plant Pathology, University of Florida, Gainesville, Florida, United States of America, 8 Biomathematics and Statistics Scotland, The James Hutton Institute, Invergowrie, Dundee, United Kingdom, 9 Escuela Politecnica del Ejercito, Sangolqui, Ecuador, 10 Wageningen UR Plant Breeding, Wageningen, The Netherlands, 11 The Sarvari Research Trust, Henfaes Research Centre, Abergwyngregyn, Llanfairfechan, United Kingdom, 12 Food and Environment Research Agency, Sand Hutton, York, United Kingdom, 13 Division of Plant Sciences, College of Life Sciences, University of Dundee at The James Hutton Institute, Invergowrie, Dundee, United Kingdom

What is new since StPetersburg?

- 12plex SSR system published



Contents lists available at SciVerse ScienceDirect

Journal of Microbiological Methods

journal homepage: www.elsevier.com/locate/jmicmeth

Efficient multiplex simple sequence repeat genotyping of the oomycete plant pathogen *Phytophthora infestans*

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What is new since StPetersburg?

- 13_A2 in NL and presence of *Rpi-blb 1* breaking strains in NL population (G3 journal)

Population Dynamics of *Phytophthora infestans* in the Netherlands Reveals Expansion and Spread of Dominant Clonal Lineages and Virulence in Sexual Offspring

Y. Li,*,† T. A. J. van der Lee,†,1 A. Evenhuis,† G. B. M. van den Bosch,† P. J. van Bekkum,† M. G. Förch,† M. P. E van Gent-Pelzer,† H. M. G. van Raaij,† E. Jacobsen,‡ S. W. Huang,* F. Govers,§,** V. G. A. A. Vleeshouwers,‡ and G. J. T. Kessel†

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What is new since StPetersburg?

- 13_A2 confirmed in China

Plant Pathology (2012) Doi: 10.1111/j.1365-3059.2012.02687.x

Population structure of *Phytophthora infestans* in China – geographic clusters and presence of the EU genotype Blue_13

Y. Li[a], T. van der Lee[b]*, J. H. Zhu[c], G. H. Jin[d], C. Z. Lan[e], S. X. Zhu[f], R. F. Zhang[g], B. W. Liu[h], Z. J. Zhao[i], G. Kessel[b], S. W. Huang[a] and E. Jacobsen[f]

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What is new since StPetersburg?

- 13_A2 confirmed in India

Journal of Phytopathology

J Phytopathol
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doi: 10.1111/jph.12031

Division of Plant Pathology, Indian Institute of Horticultural Research, Bangalore, India

Emergence of 13_A2 Blue Lineage of *Phytophthora infestans* was Responsible for Severe Outbreaks of Late Blight on Tomato in South-West India

Pallem Chowdappa[1], Nirmal B. J. Kumar[1], Shivanna Madhura[1], Mohan S. P. Kumar[1], Kevin L. Myers[2], William E. Fry[2], Julie N. Squires[3] and David E. L. Cooke[3]

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Received May 16, 2012; accepted September 4, 2012

What is new since StPetersburg?

- Clonal populations US-1 and KE-1 dominant in Sub-Saharan Africa

Plant Pathology (2013) **62,** 154–165 Doi: 10.1111/j.1365-3059.2012.02608.x

Phytophthora infestans populations in central, eastern and southern African countries consist of two major clonal lineages

B. B. Pule[ab], J. C. Meitz[b], A. H. Thompson[a], C. C. Linde[c], W. E. Fry[d], S. D. Langenhoven[b], K. L. Meyers[d], D. S. Kandolo[a], N. C. van Rij[e] and A. McLeod[b*]

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What is new since StPetersburg?

- Evidence for sexual recombination in European *P. infestans* reviewed

Plant Pathology (2012) Doi: 10.1111/j.1365-3059.2012.02685.x

REVIEW

What is the evidence for sexual reproduction of *Phytophthora infestans* in Europe?

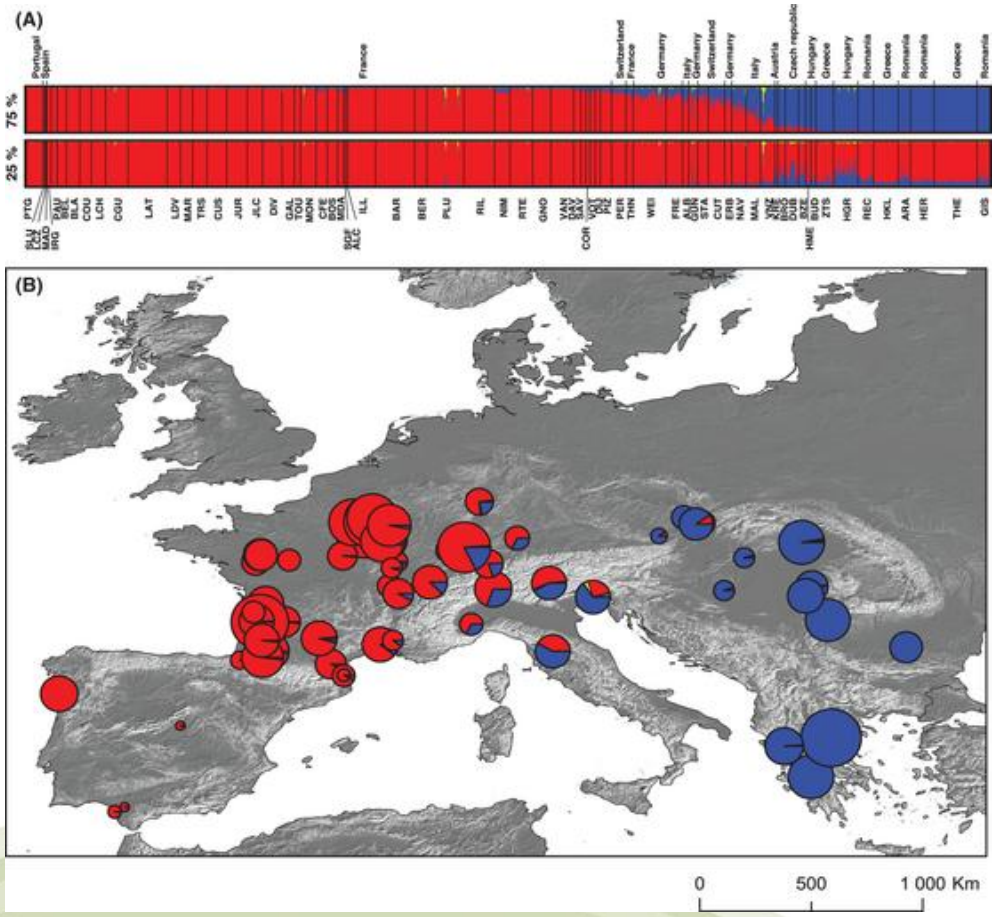
J. E. Yuen* and B. Andersson

Department of Forest Mycology and Plant Pathology, Swedish University of Agricultural Sciences, SE 750 05, Uppsala, Sweden

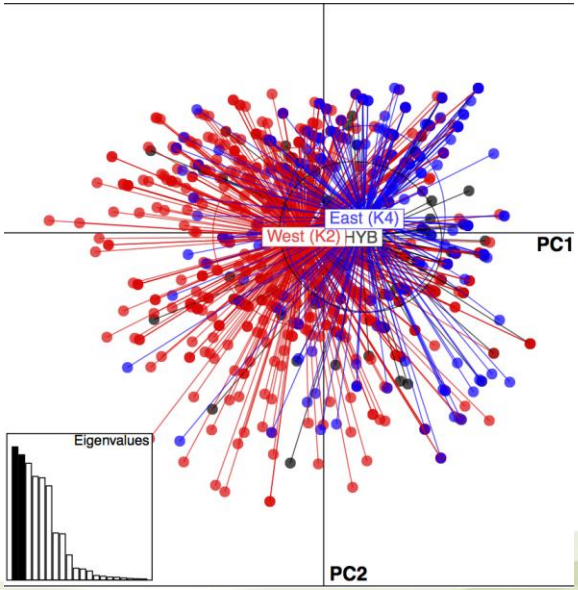
What is new since StPetersburg?

- **Hamed & Gisi** 2012 Generation of pathogenic F1 progeny from crosses of *Phytophthora infestans* isolates differing in ploidy. *Plant Pathology*
  - Ploidy of some EU isolates and increased viability of diploid x diploid crosses compared to crosses involving triploid isolates confirmed
- **Lees, et al** 2012. The Effect of a dominant *Phytophthora infestans* genotype (13_A2) in Great Britain on host resistance to foliar late blight in commercial potato cultivars. *Potato Research* 55, 125-134
  - Confirmed decrease in resistance ratings

Genetic signature of a range expansion and leap-frog event after the recent invasion of Europe by the grapevine downy mildew pathogen *Plasmopara viticola*

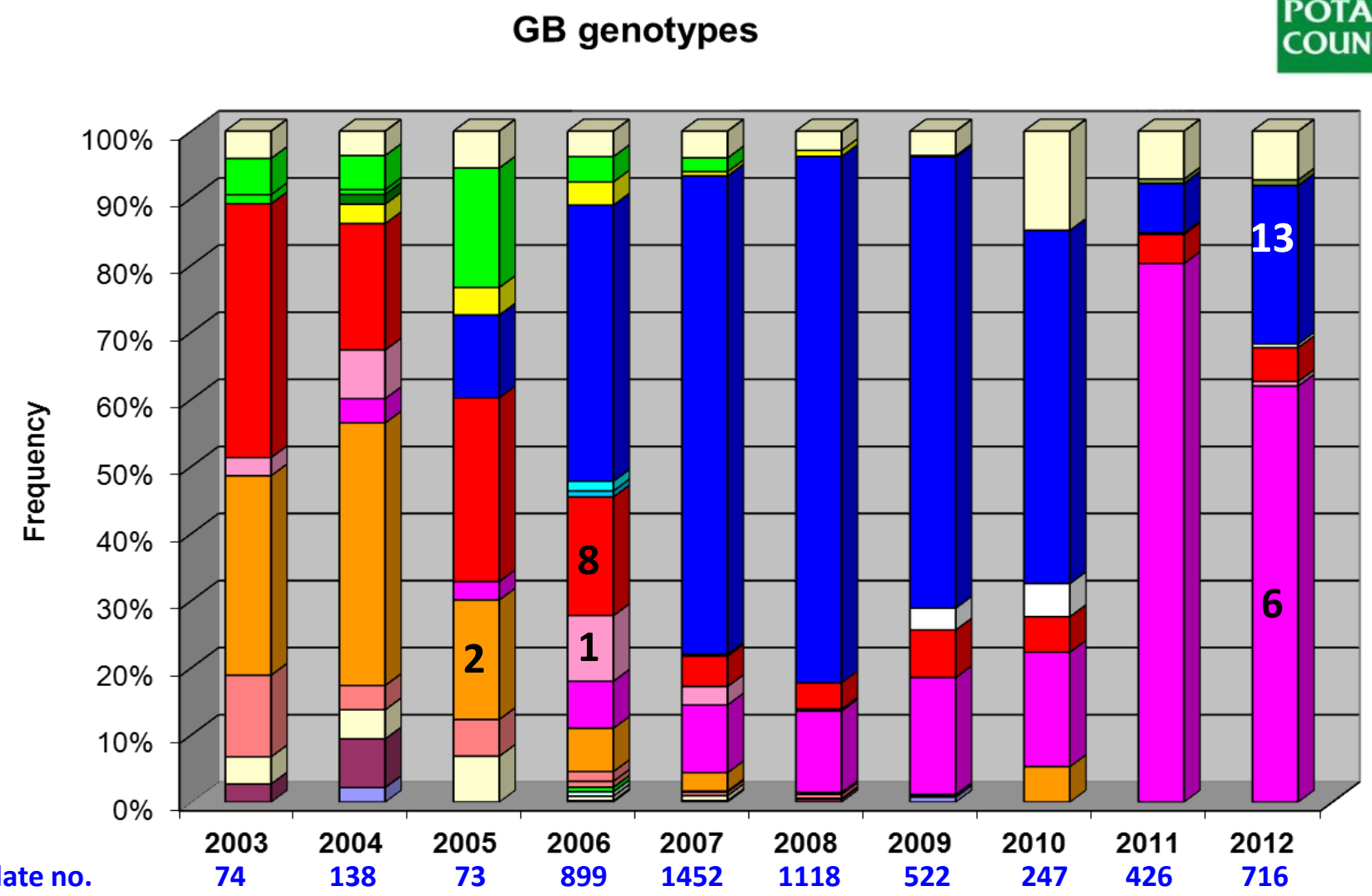


- 1146 samples from 68 vineyards
- 8 SSR loci
- 515 genotypes
- Generally low diversity interbreeding population suggests single introduction in 1870s
- Weak discrimination of East and West populations



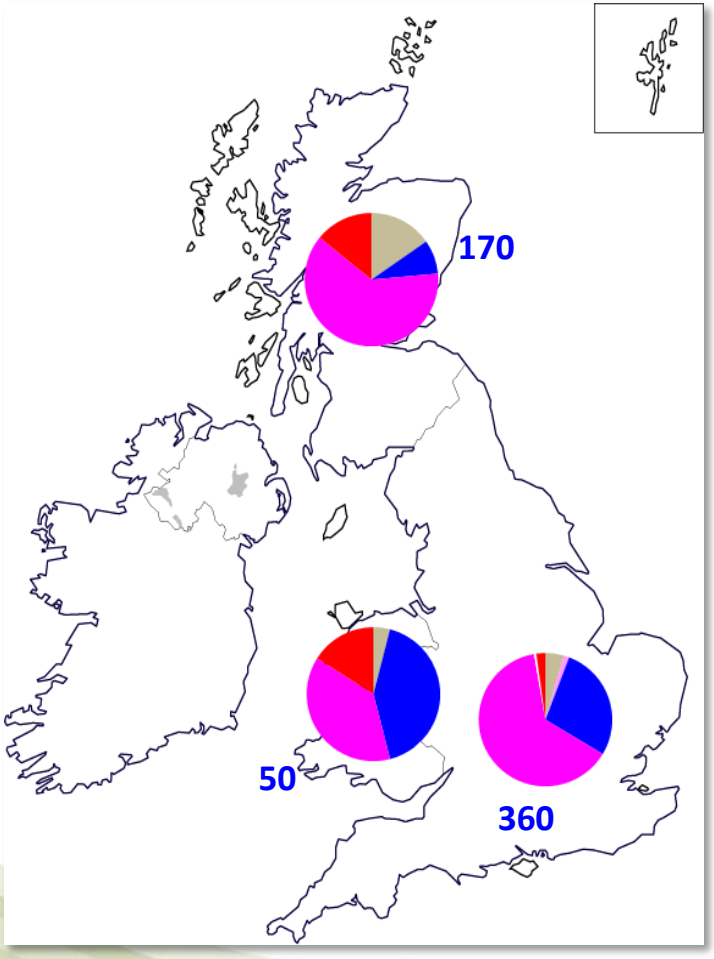
Fontaine *et al* Molecular Ecology 2013
Volume 22, Issue 10, pages 2771-2786, 18 MAR 2013 DOI: 10.1111/mec.12293
http://onlinelibrary.wiley.com/doi/10.1111/mec.12293/full#mec12293-fig-0004

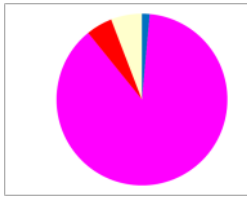
GB *P. infestans* population update



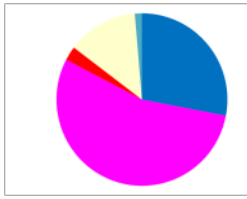
2012 GB *P. infestans* genotype by country

- **Scotland** higher proportion of 6_A1 relates to last years dominance of this genotype. Greater number of novel genotypes than in England and Wales
- **England** 6_A1 dominated despite a cooler wetter season that was expected to have been more conducive to 13_A2
- **Wales** greatest frequency of 13_A2
- **Summary**
  - GB still dominated by two agressive clonal lineages
  - primary inoculum from last season is important

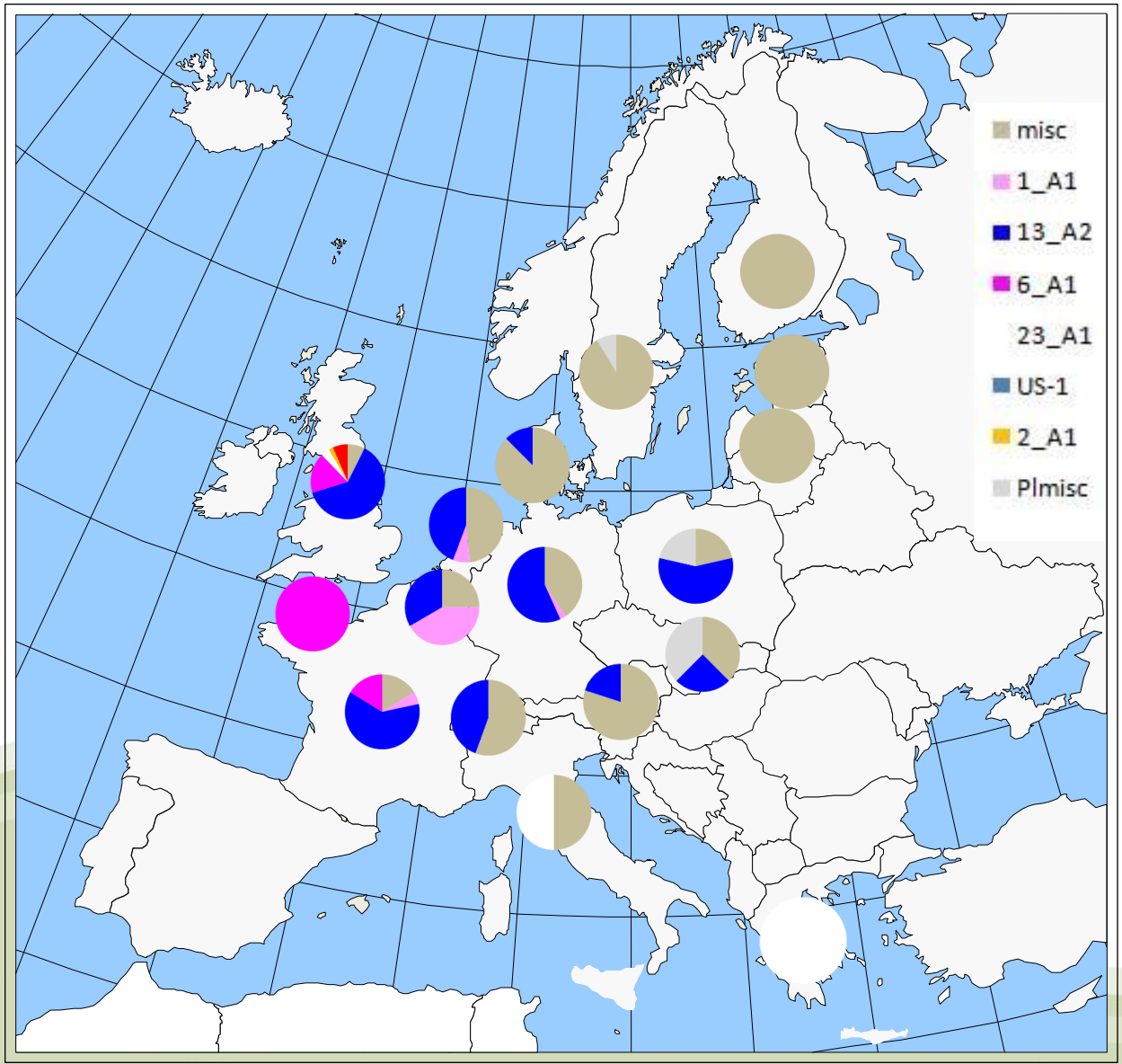




2011



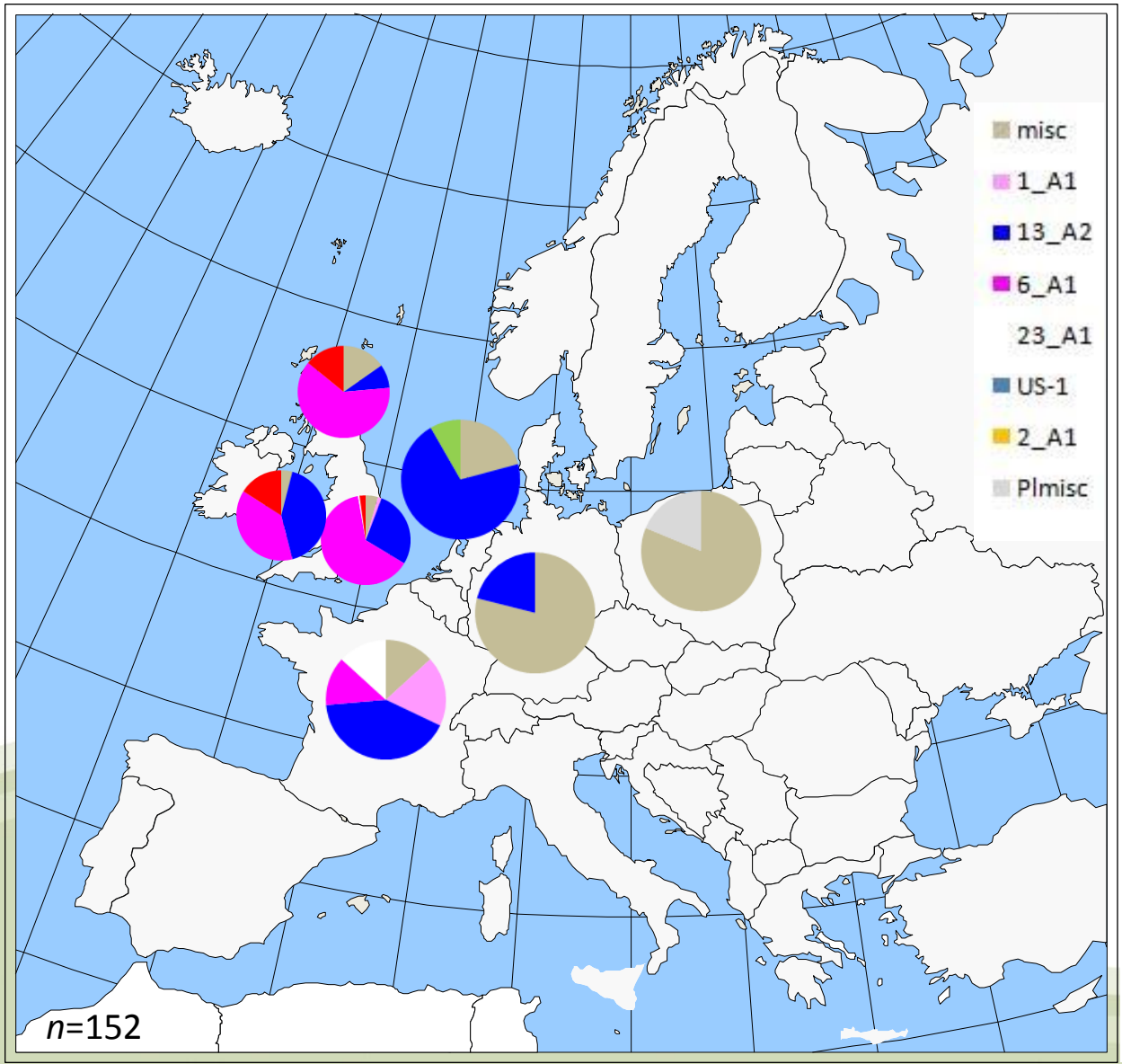
Sample of EU *P. infestans* genotypes (2008-10) (*n*=350)



- 13_A2 still present in many areas (less due to reduced Metalaxyl use?)
- A high proportion of novel 'misc' types particularly in NE
- New genotype in PL, SK & SE
- 23_A1 on tomato in Italy & GK
- Thanks to Bayer and Syngenta, Howard Hinds, Vangelis Vellios

Genotypic diversity in 2012 (mainland Europe)

The James Hutton Institute

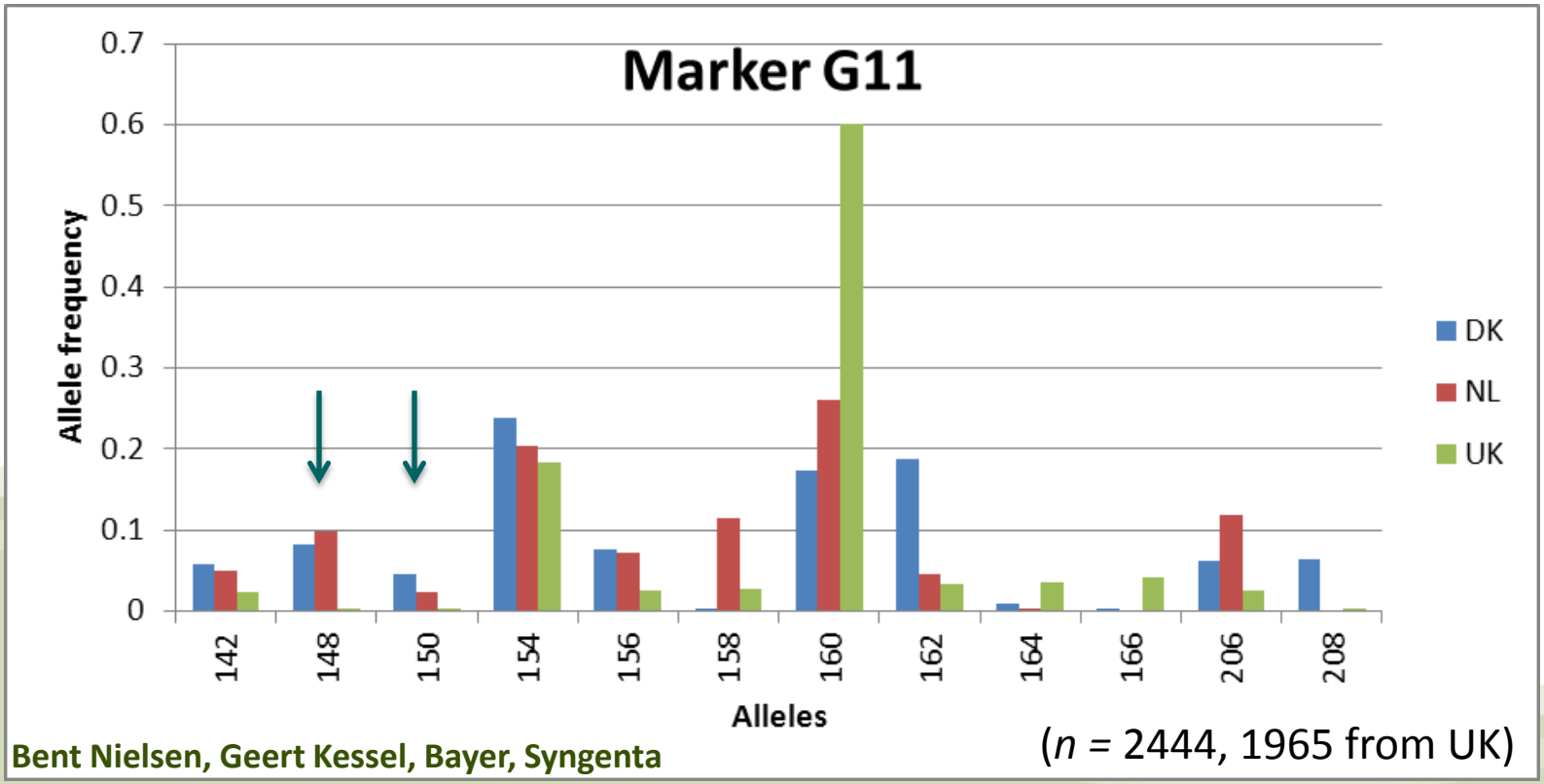


- **Christophe Andreas-Braun (fungicide session)**
- **France (*n* = 53) the population remains mainly clonal**
- **Germany (*n*= 57) fewer 13_A2 isolates and more novel misc genotypes**
- **Netherlands (*n*=24) 13_A2 dominant with misc and genotype 33 also present**
- **Poland (*n*=16) One Polish clone and many diverse isolates**
- **UK (PCL) (*n*=578)**

Bayer CropScience

SSR Allele frequency differences

- Many alleles in common across Europe
- Country-specific differences in allele frequencies noted
- Comparisons on standard data in database easier & faster



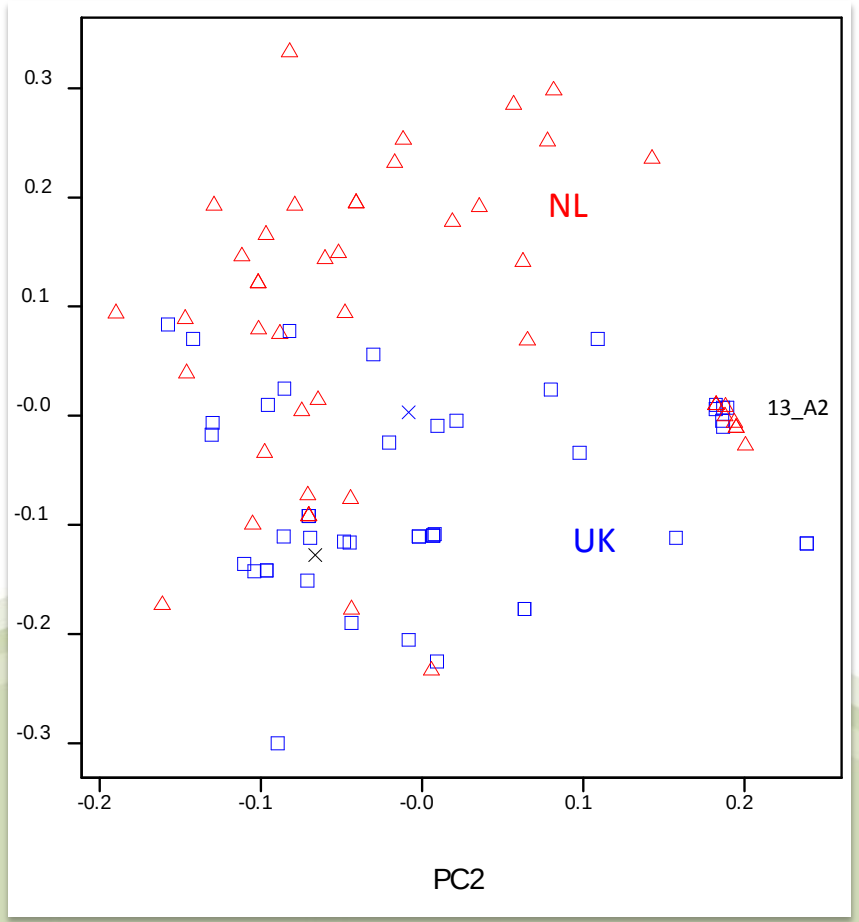
Bent Nielsen, Geert Kessel, Bayer, Syngenta

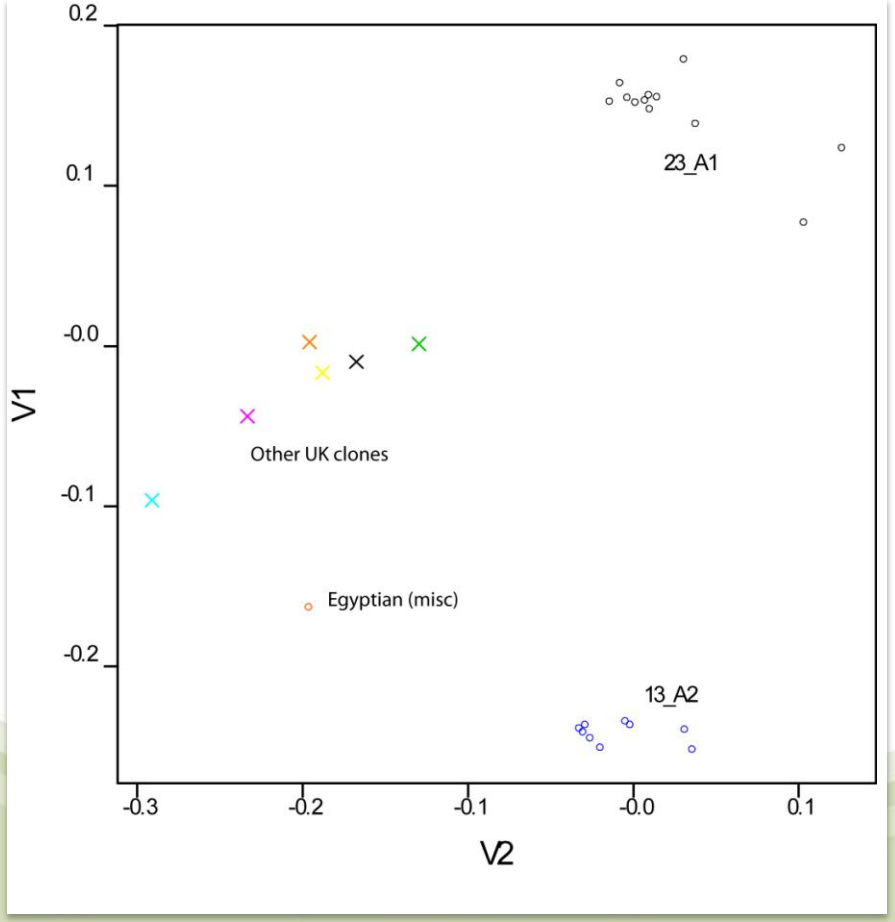
(*n* = 2444, 1965 from UK)

Population comparisons – SSRs & POLYSAT

- Li *et al* 2012 *J. Microb. Methods* - 12 plex script
- Clones versus novel isolates
- NL vs UK populations

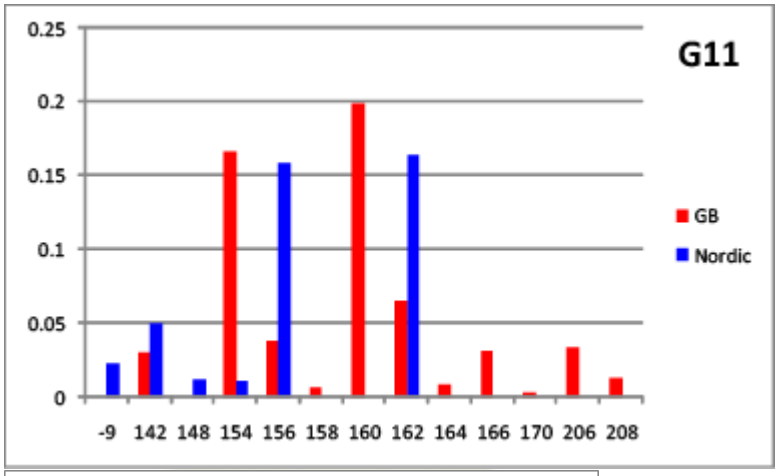
- Sherif El Ganainy, Giza, Egypt
- Clonal population
- Sub clonal comparisons may identify source population

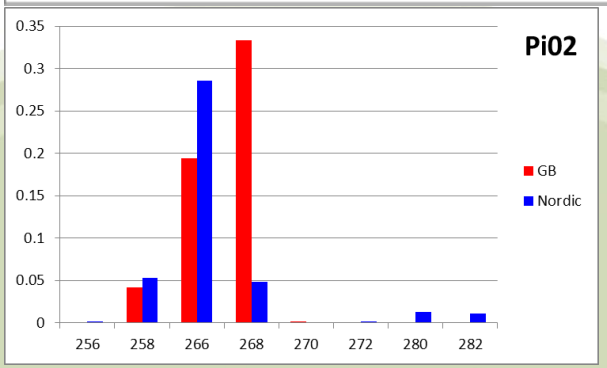


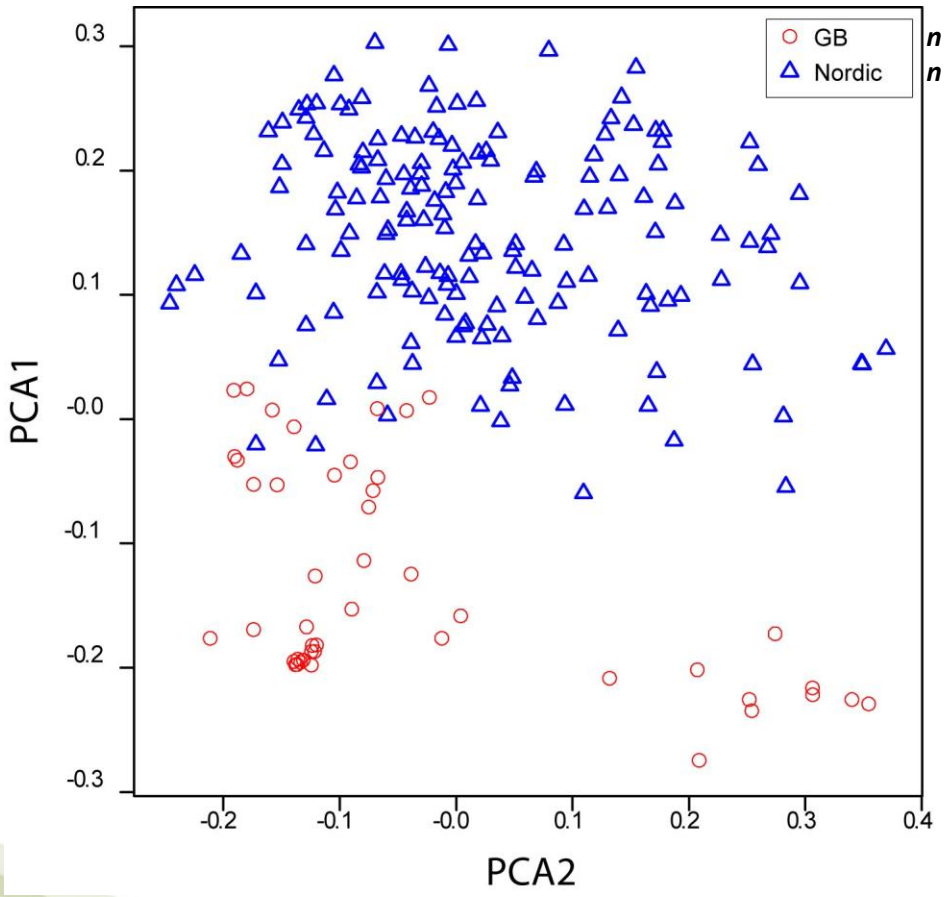


UK versus Nordic regions

- Nordic population (2003) more diverse than GB (2006)
- Populations distinct due to specific alleles







Nordic data (Brurberg, Elameen, From Brurberg *et al*., 2011) GB data - JHI

The Wheat Rust Toolbox for global wheat rust surveillance and monitoring

Jens G. Hansen[1], Poul Lassen[1], Mogens Hovmøller[1] & David Hodson[2]

AARHUS UNIVERSITY

Global Rust Reference Center

Wheat Rust Toolbox

CIMMYT
International Maize and Wheat Improvement Center

RustTracker

Wheat Rust Toolbox ICT framework

EuroWheat

GRRC

RustTracker

Wheat rust toolbox

Models and applications layer [.NET]

XML, CSV

Exchange and integration with external platforms

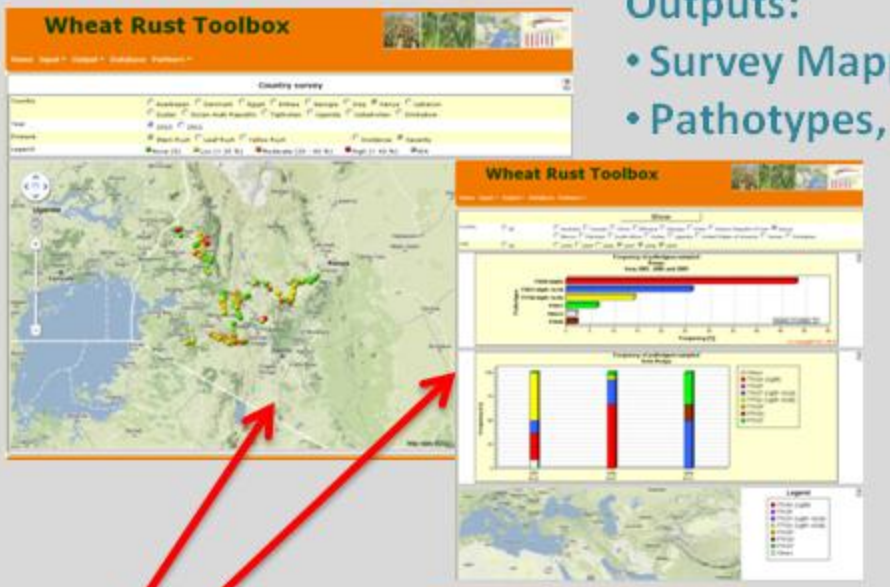
SQL Databases: Host-Pathogen etc.

Data Management: Wheat Rust Toolbox

NB: Generic - Applicable to all rusts & other diseases

On-line Data Entry

Smartphone / tablet survey tool



Outputs:
- Survey Mapping
- Pathotypes, +...

Quality control/publish

User Management

Data Export / Exchange

Wheat Rust Toolbox

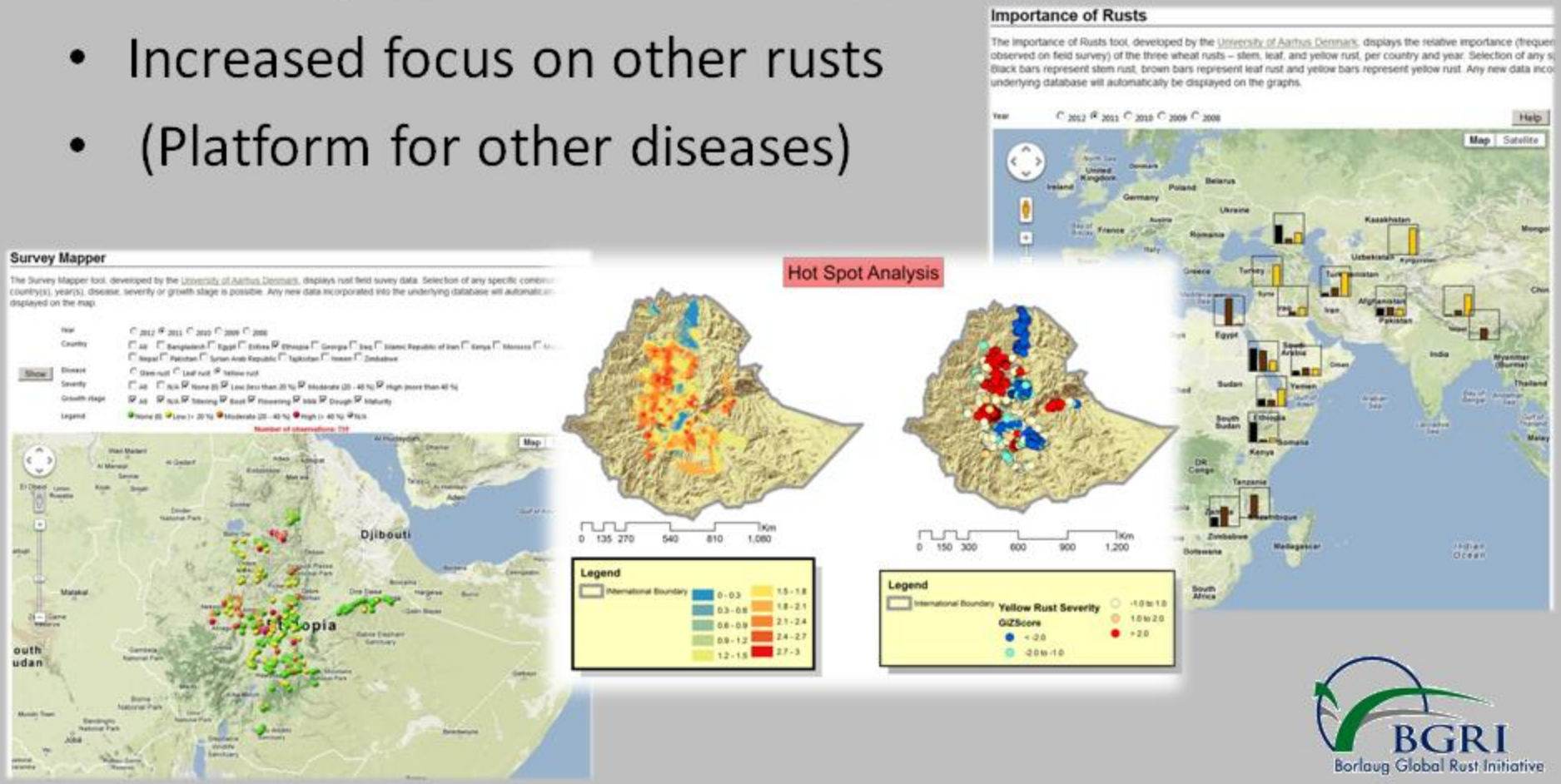
Host Pathogen Dbase
(survey, pathotypes,)
[*Trap nursery, Barberry, Molecular*]

External Applications
e.g., RustMapper

AARHUS UNIVERSITET

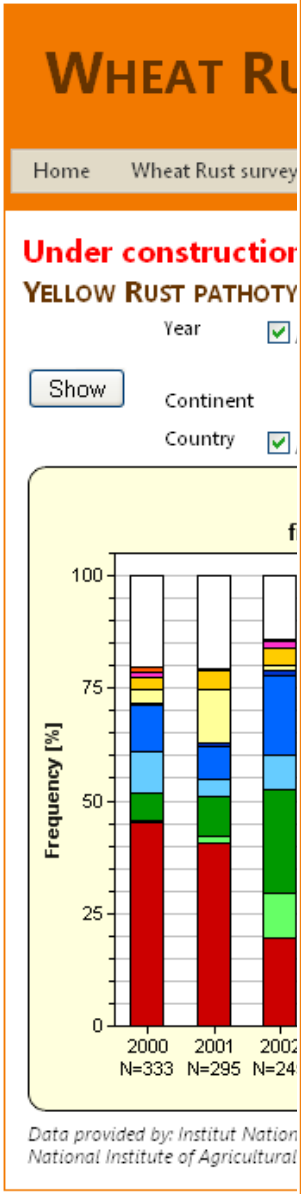
Rust Tracker.org / Toolbox – Platform for all rusts

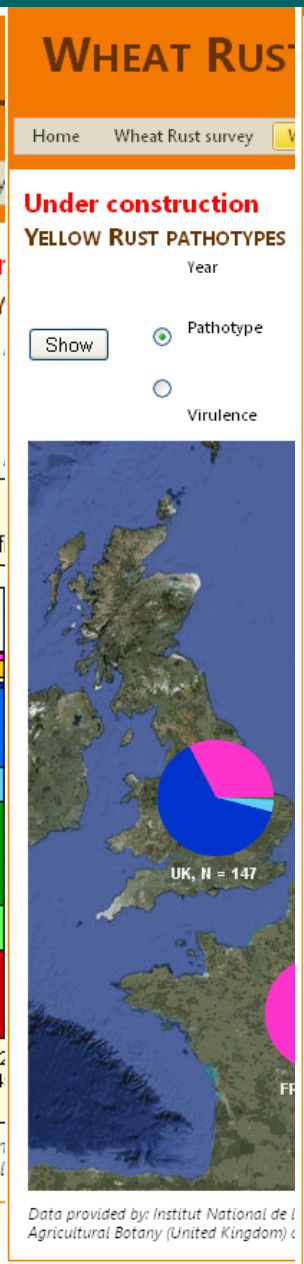
- All examples show Yellow Rust
- Increased focus on other rusts
- (Platform for other diseases)

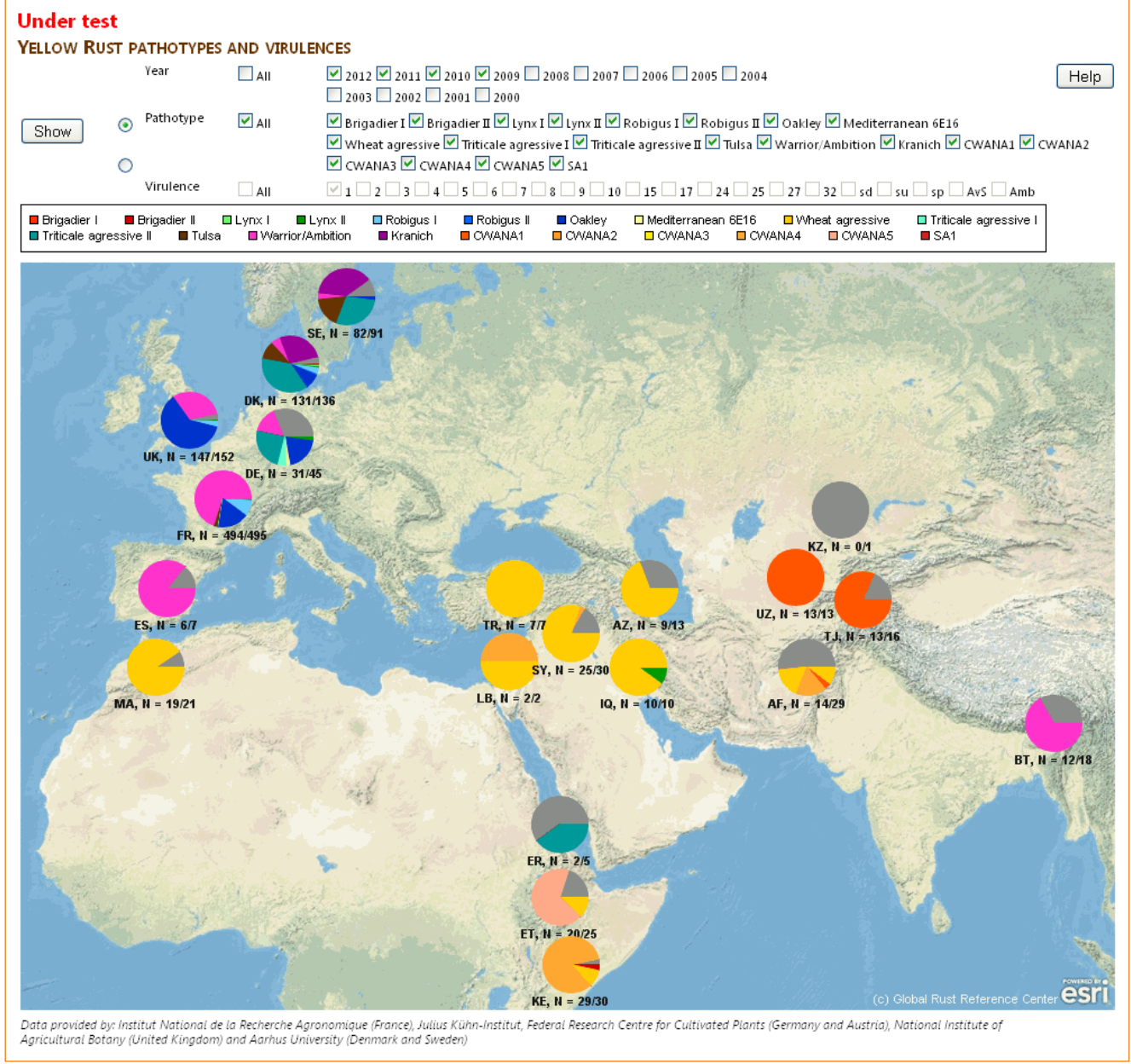


BGRI
Borlaug Global Rust Initiative

Monitoring: Virulences / Pathotypes

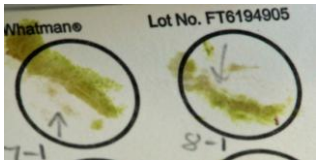






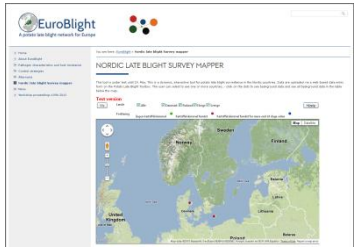
Data provided by: Institut National de la Recherche Agronomique (France), Julius Kühn-Institut, Federal Research Centre for Cultivated Plants (Germany and Austria), National Institute of Agricultural Botany (United Kingdom) and Aarhus University (Denmark and Sweden)

Potato Late Blight Toolbox ICT framework

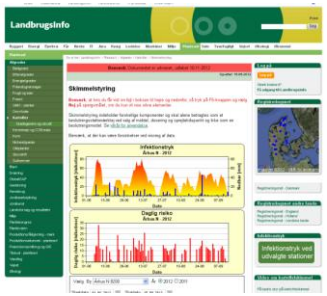


FTA card tracking

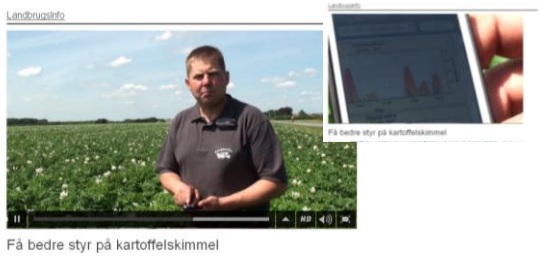
EuroBlight



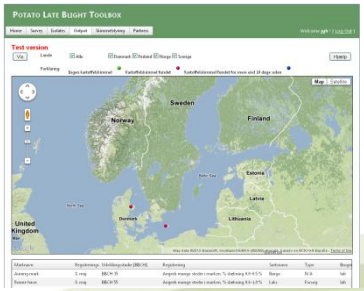
Extension service



SmartPhone APPs



Potato late blight toolbox



Models and applications layer [.NET]

XML, CSV

Exchange and integration with external platforms

SQL Databases: Host-Pathogen etc.

Potato Late Blight Toolbox: Status

- A Potato Late Blight Toolbox constructed
- Existing *P. infestans* data to be transferred to new Host – Pathogen DB that stores the global wheat rust data.
- Data entry tools, data management tools and display tools can be re-used for *P. infestans* with minor adaptations.
- Include R-statistical server based components. This is under development
- Import of data and data visualization on Web / smartphone / Web services
- Obvious synergy between experiences from organisation, integration and collaboration on a global scale from the Wheat rust databases

Conclusions, questions & thanks

The James Hutton Institute

- *P. infestans* population diverse but structured in EU
- Database upgrade will provide more powerful analysis and visualisation tools to inform management
- We need to better understand phenotype - genotype link
- Why do clones dominate in some regions and not in others?
- Does sexual recombination drive adaptation to fungicides & host resistance? Does theory match fact?

- **Thanks to all current and future data submitters**