

# The wheat-rust conflict: Shifty enemies and the long reach of genomics



**Diane Saunders**

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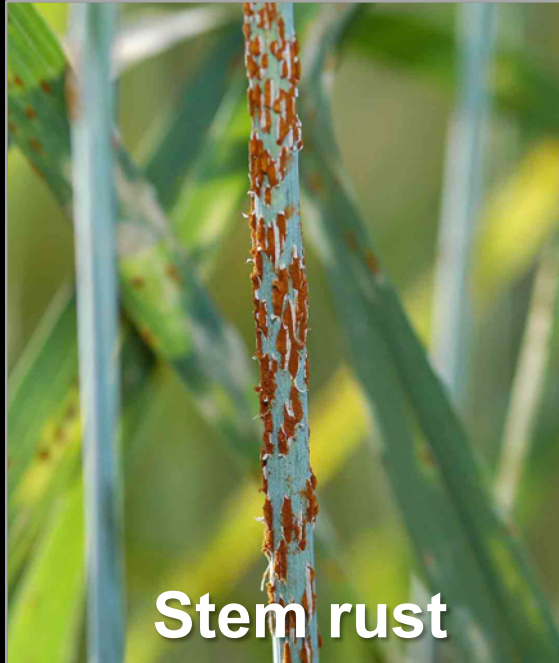


Photo: Matt Heaton



# The Wheat rust “Cereal killers”

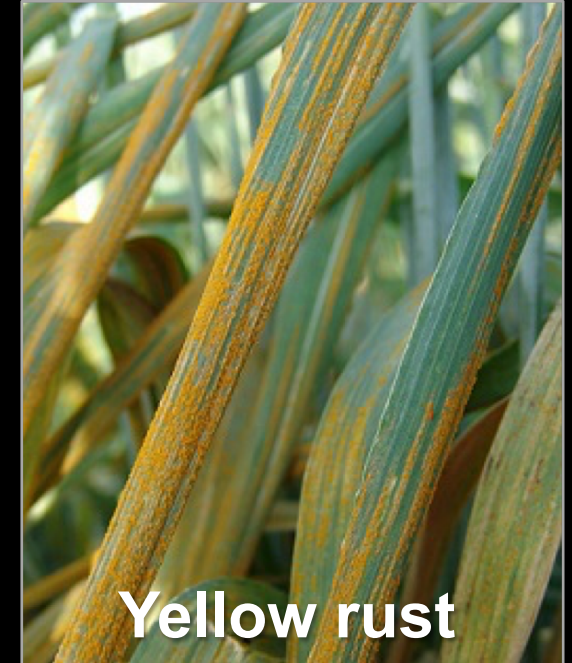
Pucciniomycotina



Globally  
6.2 million tonnes lost  
~ **\$1.12 billion per yr.**



Most common and  
widely distributed  
**>SR or YR per yr.**



Globally  
5.47 million tonnes lost  
~ **\$1 billion per yr.**

**Rust fungi .... Unculturable and complex!**



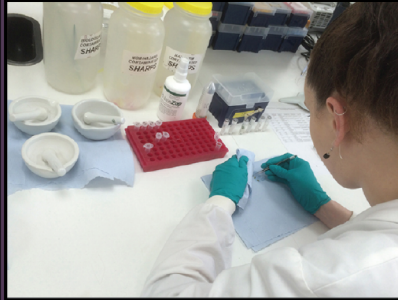
# Field pathogenomics

## Pathogen diagnostics & surveillance

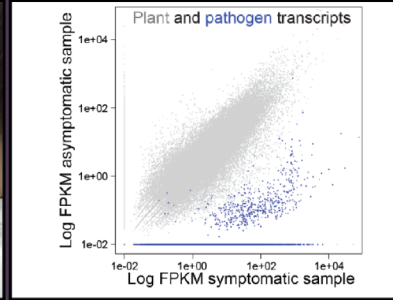
< 3 months



1 Field samples



2 Transcriptome sequencing



3 Data analysis

Pathogen & host: Genotype + Transcriptome

Confirm new disease outbreaks

Wheat blast

Track global pathogen dispersal

Yellow rust

Study host responses in the field

Yellow rust

Monitor mutations in fungicide targets

Yellow rust

Link dispersal to climatic changes in distribution

Stem rust



## 2013 Outbreaks in Germany and Ethiopia

New strains of stem rust on wheat in Ethiopia, Germany



News > UK > Home News

### Wheat rust: The fungal disease that threatens to destroy the world crop

Experts in Europe and Africa are racing to develop resistant grain varieties as university researchers predict the likely spread across continents of the air-borne spores of the fungus

Christy Chamy | Saturday 19 April 2014 23:01 BST | 0 comments



INDEPENDENT

NATURE | NEWS

### Deadly new wheat disease threatens Europe's crops

Researchers caution that stem rust may have returned to world's largest wheat-producing region.

Shaoni Bhattacharya

02 February 2017

News > UK > Home News

### Wheat rust: The fungal disease that threatens to destroy the world crop

Experts in Europe and Africa are racing to develop resistant grain varieties as university researchers predict the likely spread across continents of the air-borne spores of the fungus

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Dangerous outbreak of stem rust on wheat in southern Ethiopia

**SeedQuest**® Date: Wed 26 Mar 2014

# Wheat stem rust becoming an increasing threat in western Europe

## Stem rust attacks in Sweden heralds the return of a previously vanquished foe

PUBLISHED: 01 NOVEMBER 2017

TTTTF, a kind of stem rust, damages tens of thousands hectares of crops in Sicily



Sicilian stem rust strain cause for concern

03 Feb 2017 Share Categories: Frontdesk / Arable



2017  
Sexual population in Sweden

2016  
Outbreak in Sicily



# What would it take for wheat stem rust to become re-established in the UK?



First record of stem rust in UK for  
> 60 years



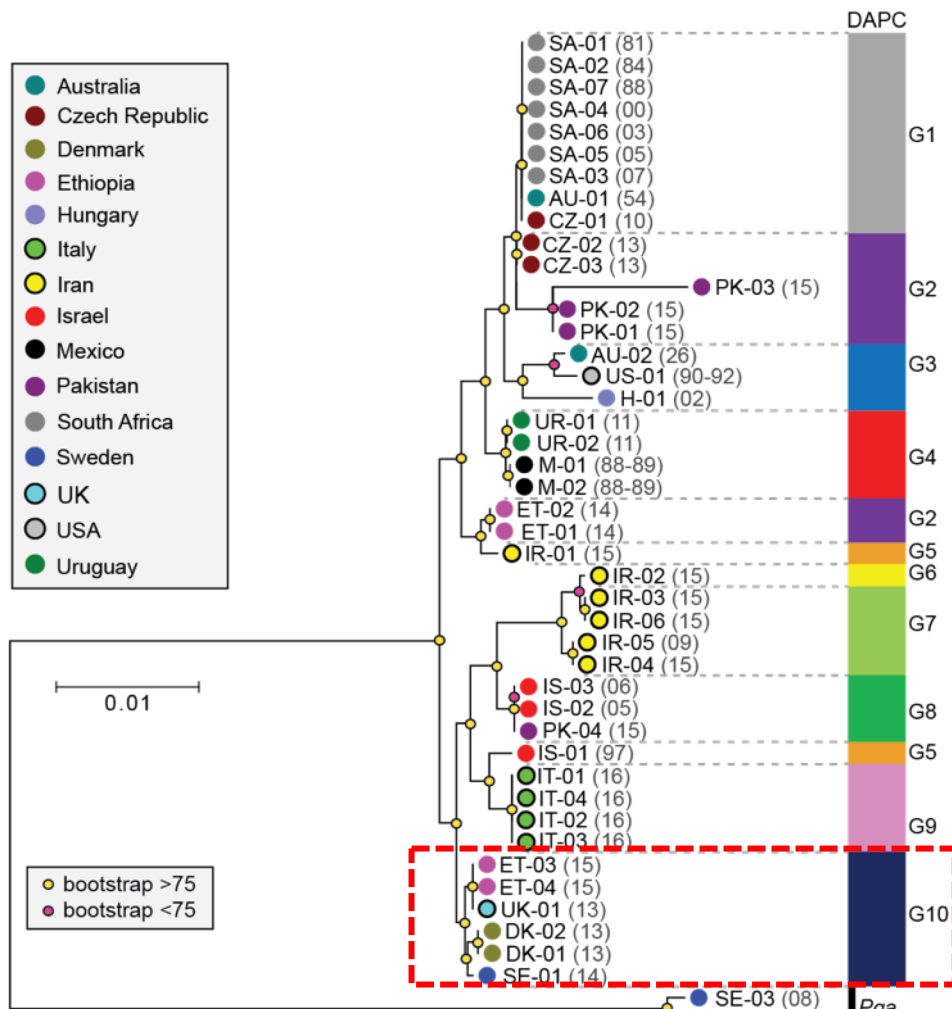
Clare  
Lewis



Antoine  
Persoons

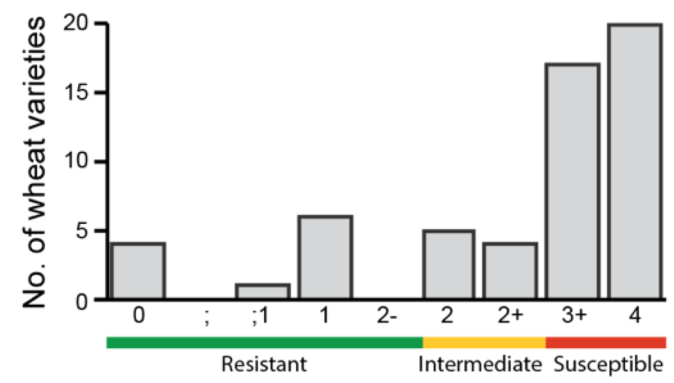


# What have we learnt about wheat stem rust in the UK?

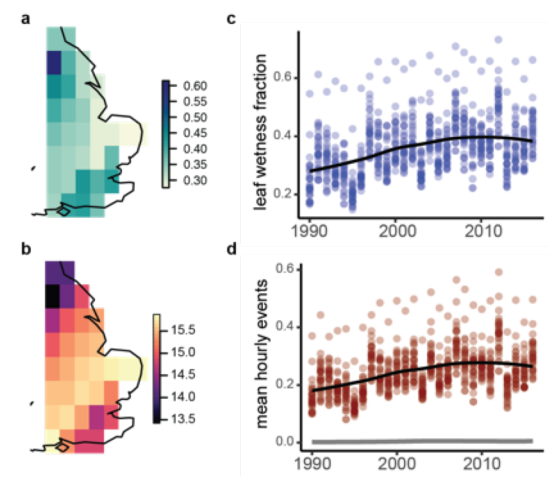


7,348,046 sites  
Maximum likelihood model

1. UK-01 belongs to the Digalu race



2. >80% UK varieties susceptible



3. Increasingly conducive conditions over past 25 years

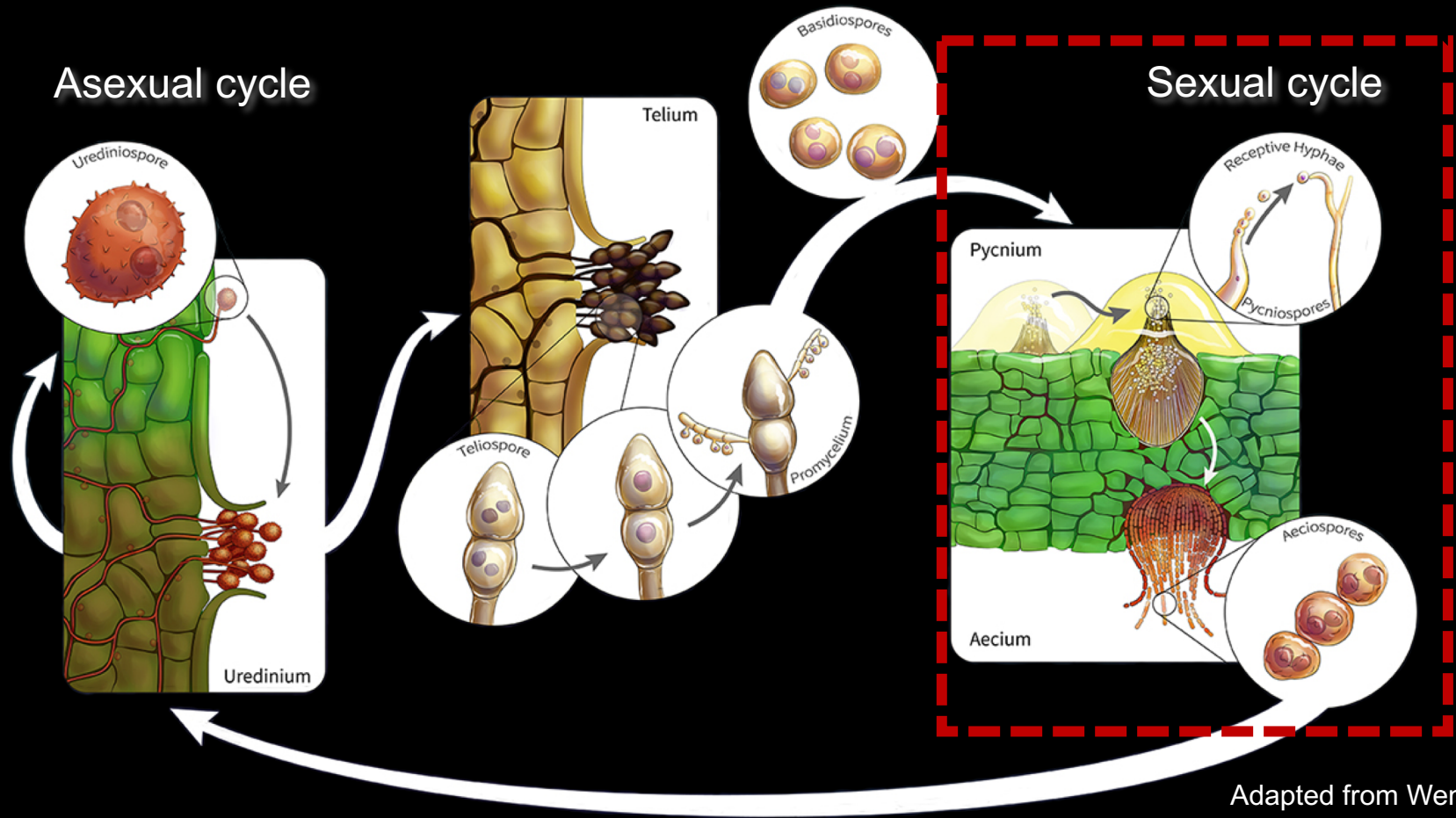


# What about the role of the alternate host?



**Common barberry**  
(*Berberis vulgaris*)

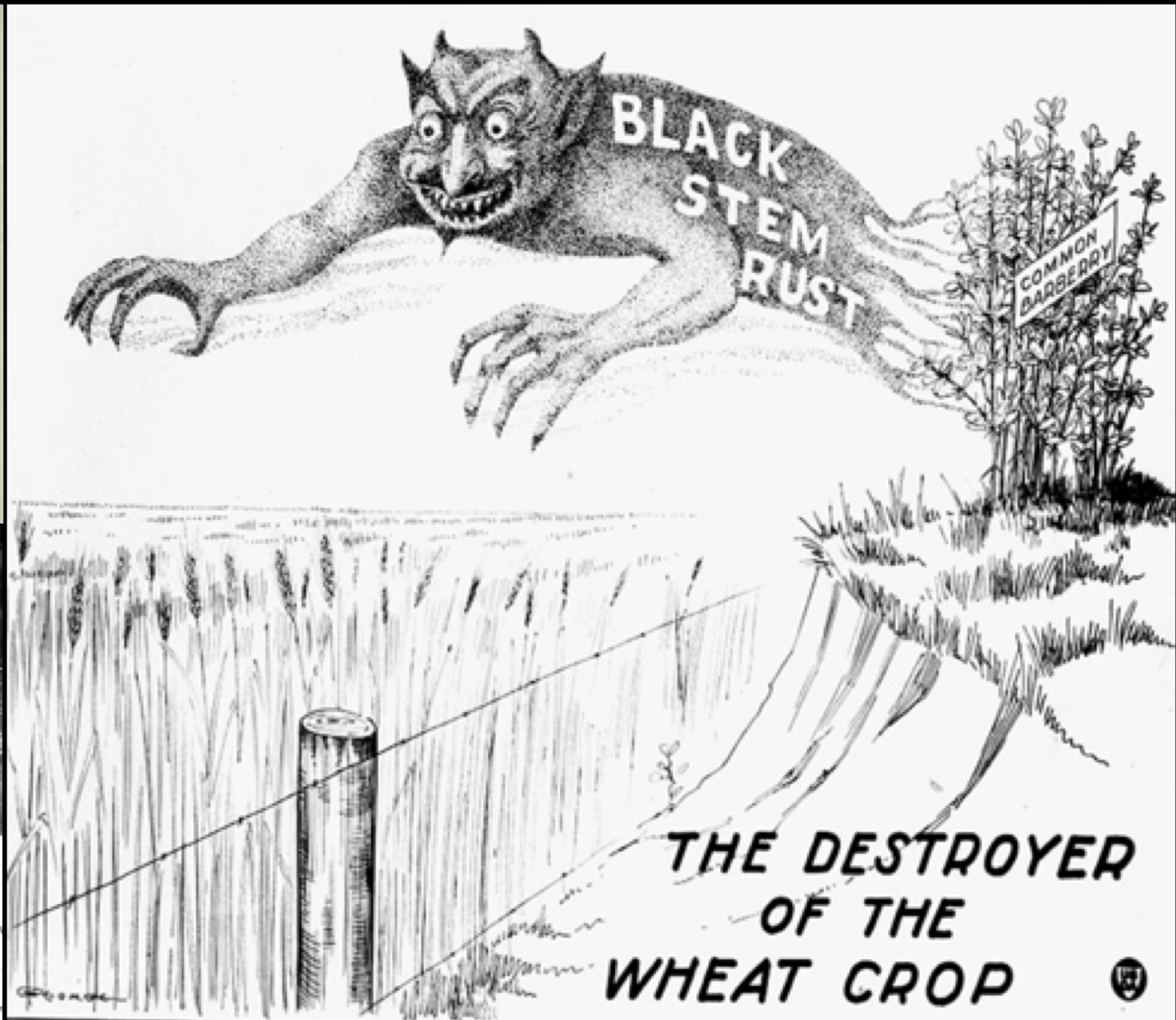
# Wheat rust life cycle



Adapted from Wende Gu



# Common barberry removal campaign



*Destroy the Common Barberry and Save the Wheat*

# Common barberry removal campaign



UNITED STATES  
DEPARTMENT OF AGRICULTURE  
DEPARTMENT CIRCULAR 269

Washington, D. C. April, 1923

**BARBERRY ERADICATION PREVENTS  
BLACK RUST IN WESTERN EUROPE.**

E. C. STAKMAN,  
Head of the Section of Plant Pathology, Division of Botany and Plant Pathology, Department of  
Agriculture, University of Minnesota, and Pathologist, Office of Cereal Investigations, Bureau of  
Plant Industry, United States Department of Agriculture.

*RECEIVED  
APR 4 1923  
BUREAU OF  
PLANT INDUSTRY*

Over 300 yrs ago "English farmers complained that black stem rust ruined crops growing near barberry bushes. So they showed their good sense by destroying the bushes"



Common Barberry spreads black stem rust to wheat and other small grains, causing an annual loss of 50,000,000 bushels.

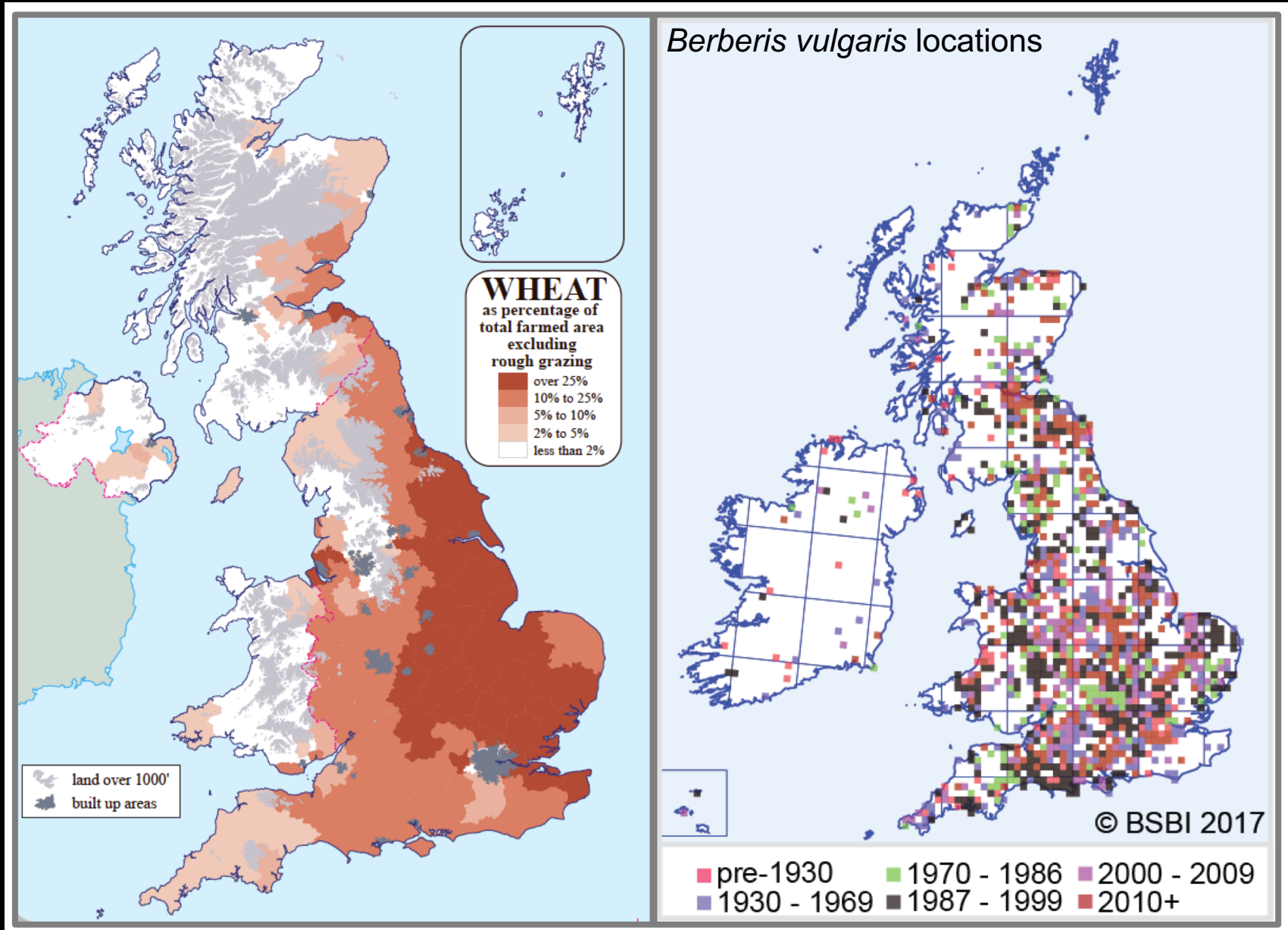
**DESTROY IT NOW!**



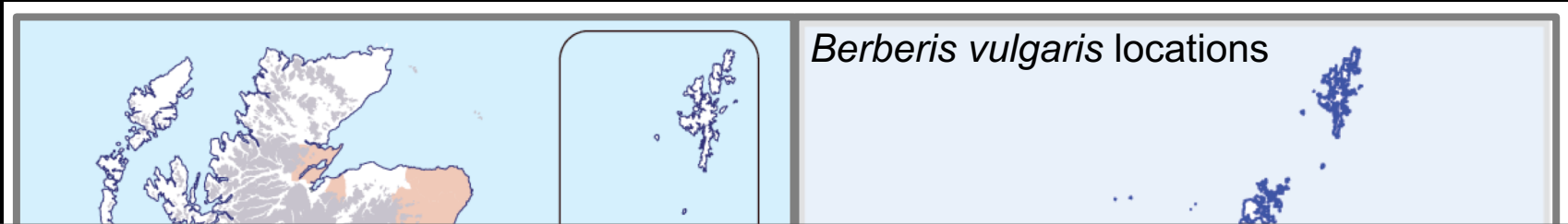
*Destroy the Common Barberry and Save the Wheat*



# Common barberry is increasing in prevalence across the UK



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*B. vulgaris* re-planted to conserve the **barberry carpet moth**, a Priority Species in the UK Biodiversity Action Plan & protected under schedule 5 of the Wildlife and Countryside Act 1981

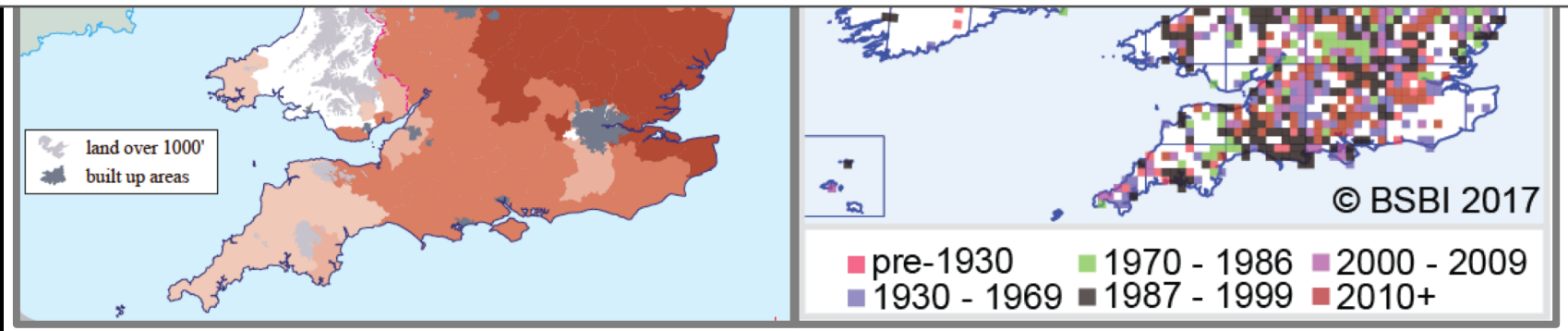
Barberry carpet moth  
(*Pareulype berberata*)



02/21/02/2017

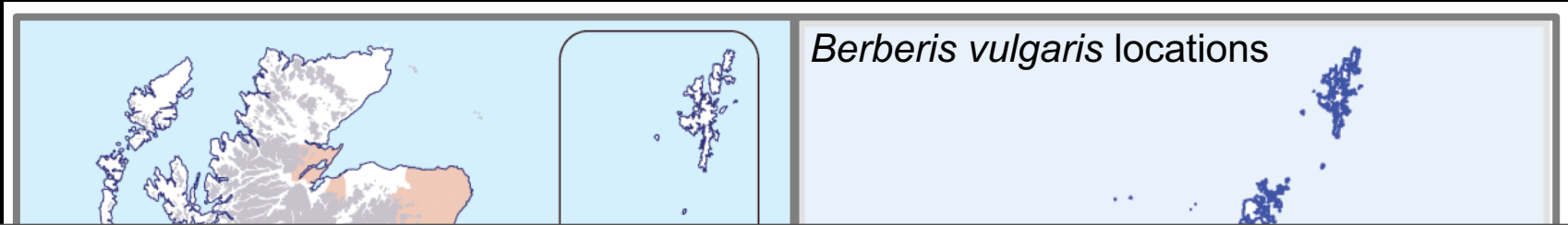
CHESTER ZOO CALLING ON VISITORS TO HELP SAVE RARE UK SPECIES

British wildlife is under threat like never before – and Chester Zoo is helping visitors join the fight to protect a rare species of moth by giving away free plants, as part of a Wildlife Connections campaign.





# Common barberry is increasing in prevalence across the UK



Need to balance risks of re-planting with potentially escalating cereal rust diversity and protection of habitat for the carpet moth

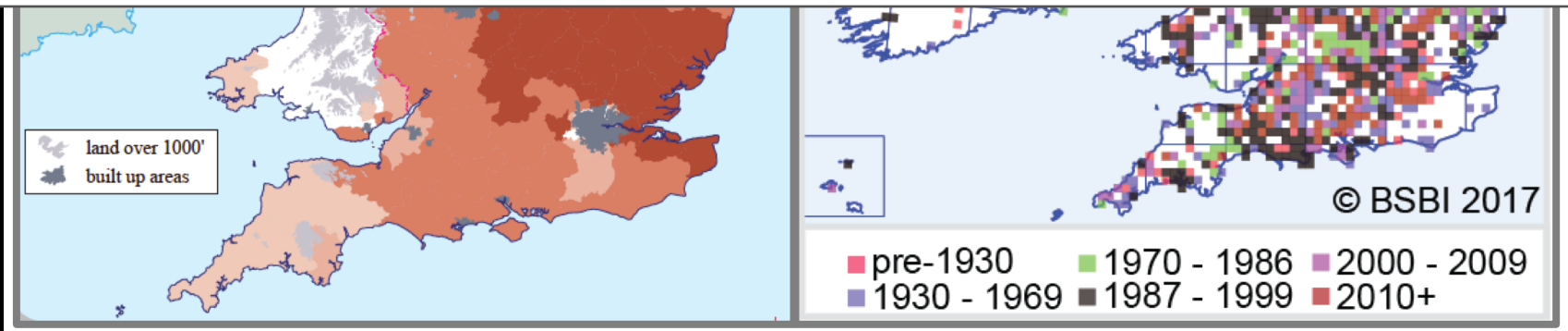
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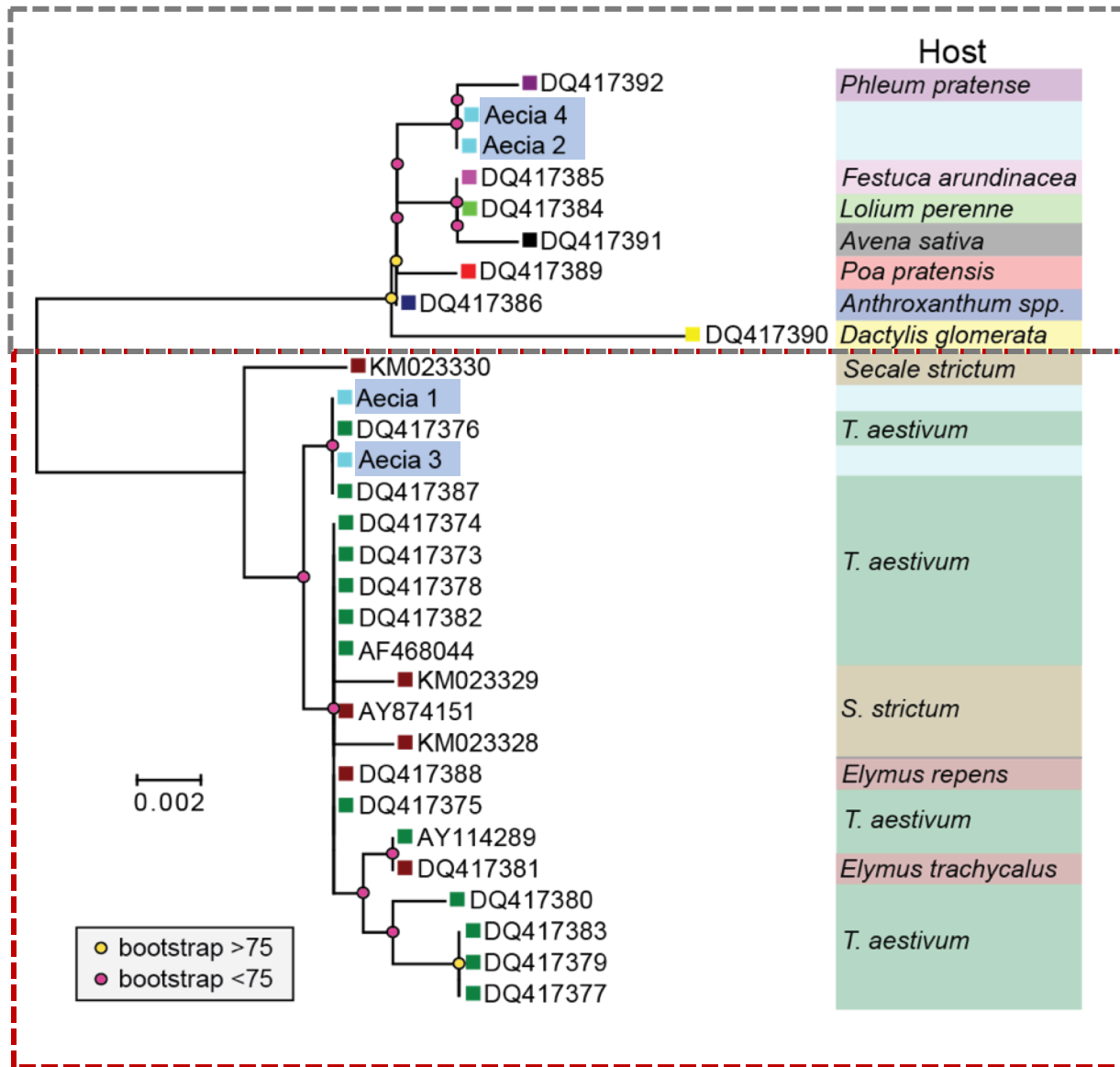
02 21/02/2017

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# Aecia are stem rust and half are similar to wheat & wild rye stem rust



Neighbor-joining approach,  
1000 replicates



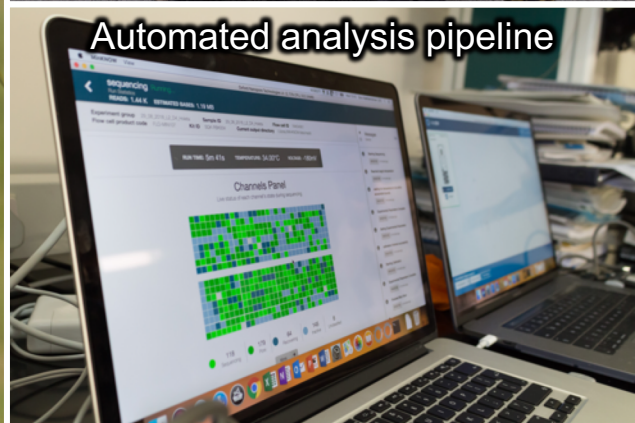
# WHAT'S NEXT?



MARPLE  
DIAGNOSTICS

**Mobile And Real-time PLant disEase diagnostics**

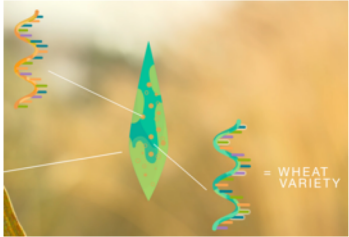
# MARPLE Diagnostics deployment in Ethiopia



Less than 3 days from sample collection to genotyping results



# Summary



- “Field pathogenomics” powerful tool to assess pathogen-host interactions directly in the field



- Wheat stem rust has been identified in the UK and becoming an increasing threat in Europe



- New mobile genotyping platform being deployed in Ethiopia

# Acknowledgments



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