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Track and trace toolbox; investigating the origins of plant pest interceptions

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EPPO HoL Workshop, 6th March 2025

Saku, Estonia



Outline of talk:

Fera Science Ltd. & Defra

Getting to track & trace - contingency plans

Outbreak process

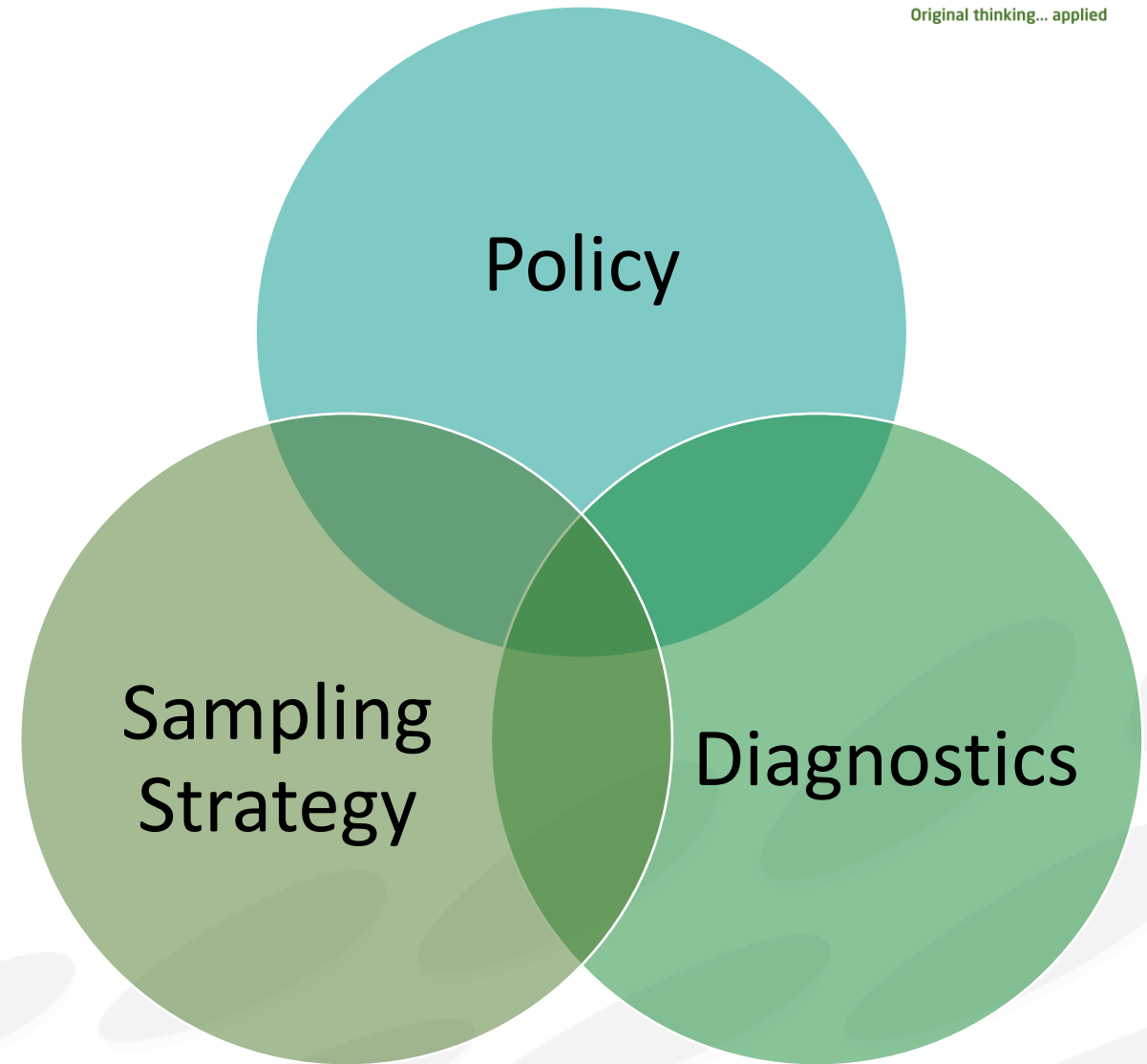
Questions arising from an outbreak

Diagnostic data interpretation

Access to information

Supporting data and bias

Examples





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Fera Science Ltd. & Defra



‘To support and develop a sustainable food chain, a healthy natural environment, and to protect the global community from biological and chemical risks’

- The labs have a scientific heritage of over 100 years
- Long history across different sites, many mergers and governance
- Since 1996 at Sand Hutton, York
- Fera has been a joint venture between Bridgepoint & Defra, since 17th January 2024



Institute for Plant
Pathology, 1914





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Contingency planning:



Original thinking... applied



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Pest specific plant health response plan:

Xylella fastidiosa (2022)

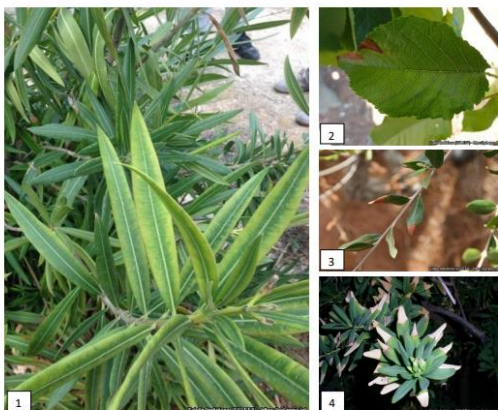


Figure 1: Early symptoms of *Xylella fastidiosa* on *Nerium oleander* in Italy. (Françoise Petter, EPPO)
Figure 2: *Xylella fastidiosa* symptoms on cherry (Donato Boscia, Inst. Sustainable Plant Protection, Bari, Italy)
Figure 3: Symptoms of *Xylella fastidiosa* on olive in Puglia, Italy (Donato Boscia)
Figure 4: Symptoms of *Xylella fastidiosa* on *Polygala myrtifolia* (Bruno Legendre, Anses, France)



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Pest specific plant health response plan:

Outbreaks of tomato brown rugose fruit virus (ToBRFV)



Figure 1. Tomato infected with tomato brown rugose fruit virus (courtesy of Neil Giltrap).



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Pest specific plant health response plan:

Outbreaks of *Anoplophora glabripennis*



Figure 1. *Anoplophora glabripennis* adult. © Fera Science Ltd.



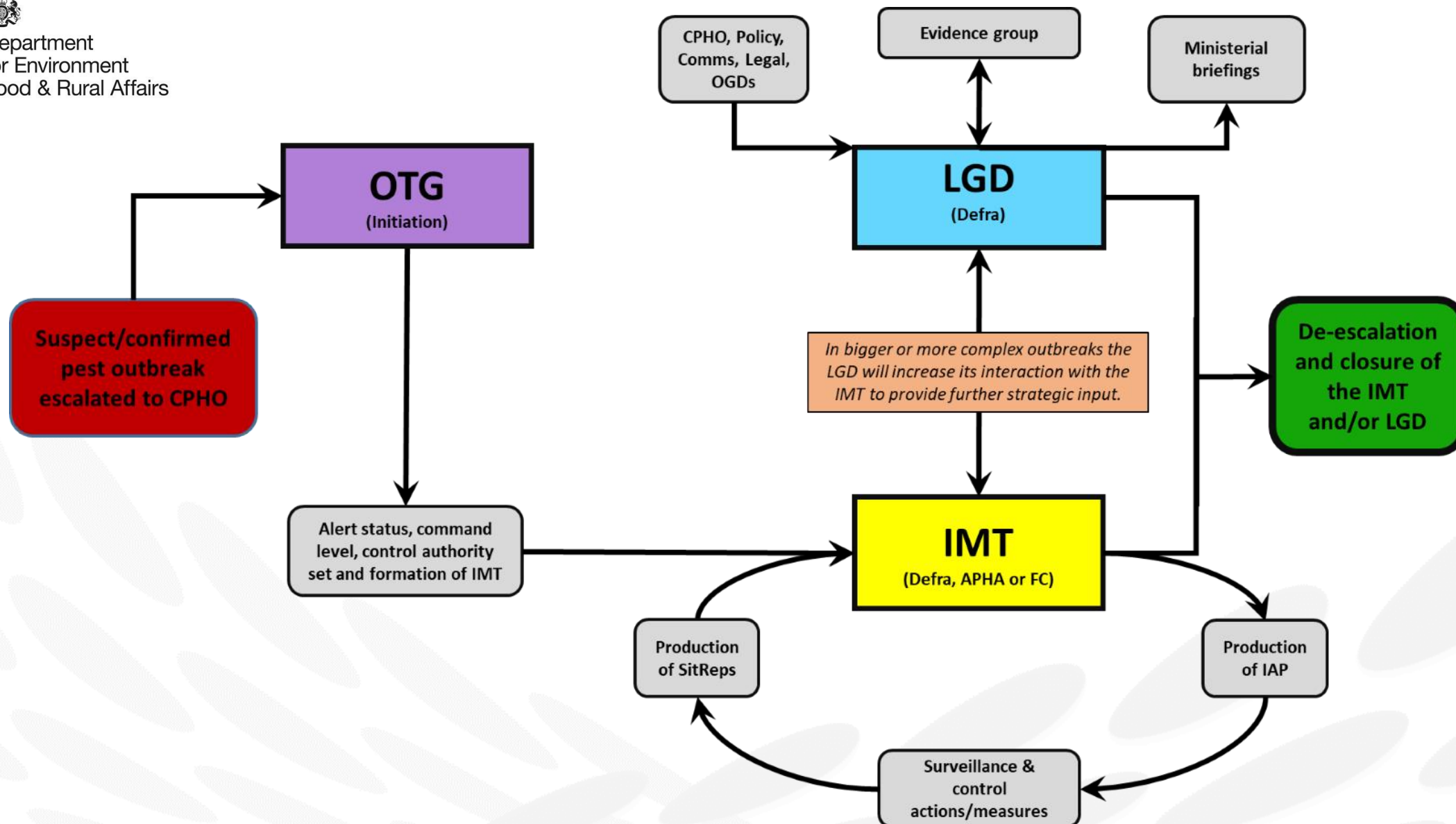
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Pest specific plant health response plan:

Outbreaks of *Leptinotarsa decemlineata* (Colorado beetle) on potato crops



Figure 1. Adult *Leptinotarsa decemlineata* feeding on a potato leaf. Image Courtesy of Fera-Science Limited © Copyright Fera-Science Limited 2016



Questions arising from an outbreak:

What was the pathway for arrival?

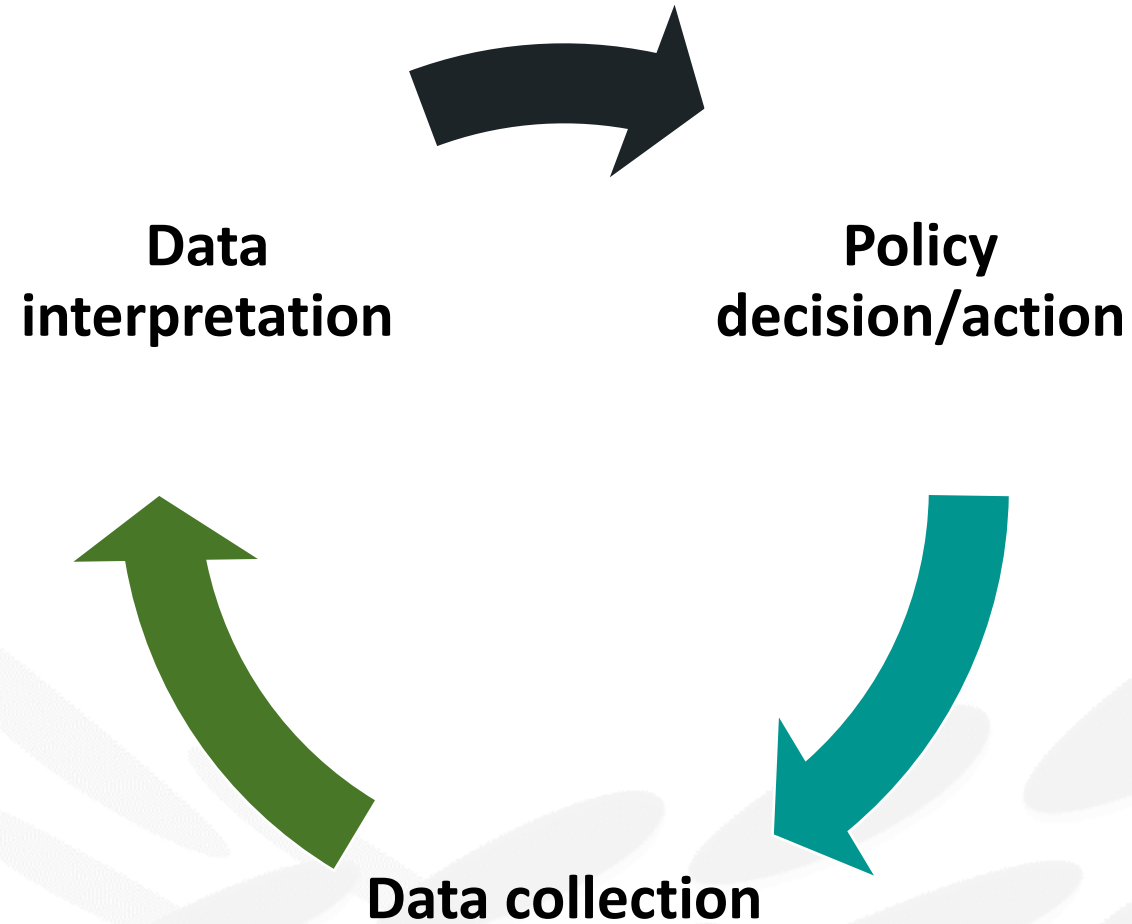
-produce, plants for planting etc

What country did the pest arrive from?

How long has the pest been present?

Two incursions have been identified, are they related?

Track & trace information cycle:



Considerations

- What information is out there?
- Expertise of the lab
- Bias due to existing data sets.
- What reference material is available – quantity and quality
- Mode of reproduction: clonal populations versus sexually recombining eukaryotes or polymorphic populations e.g. aphids

Tools:

DNA examples:

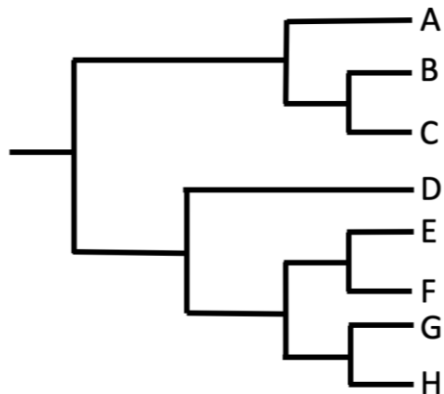
Microsatellite analysis

MLST

SNP

WGS – variable loci

WGS – phylogenetics



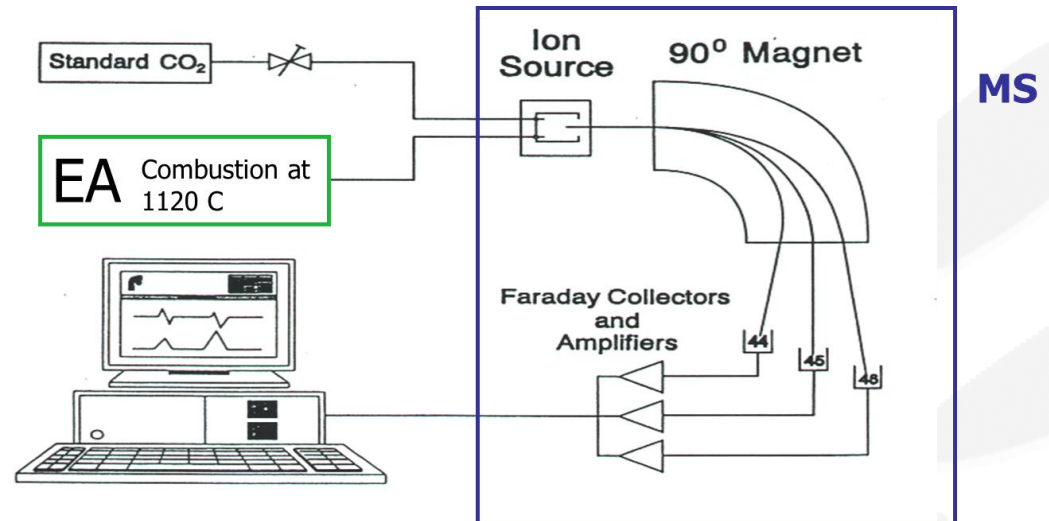
Non-DNA examples:

Isotope analysis

Context

Trade Pathway

Previous crops grown on the land



Colorado Beetle – linking findings

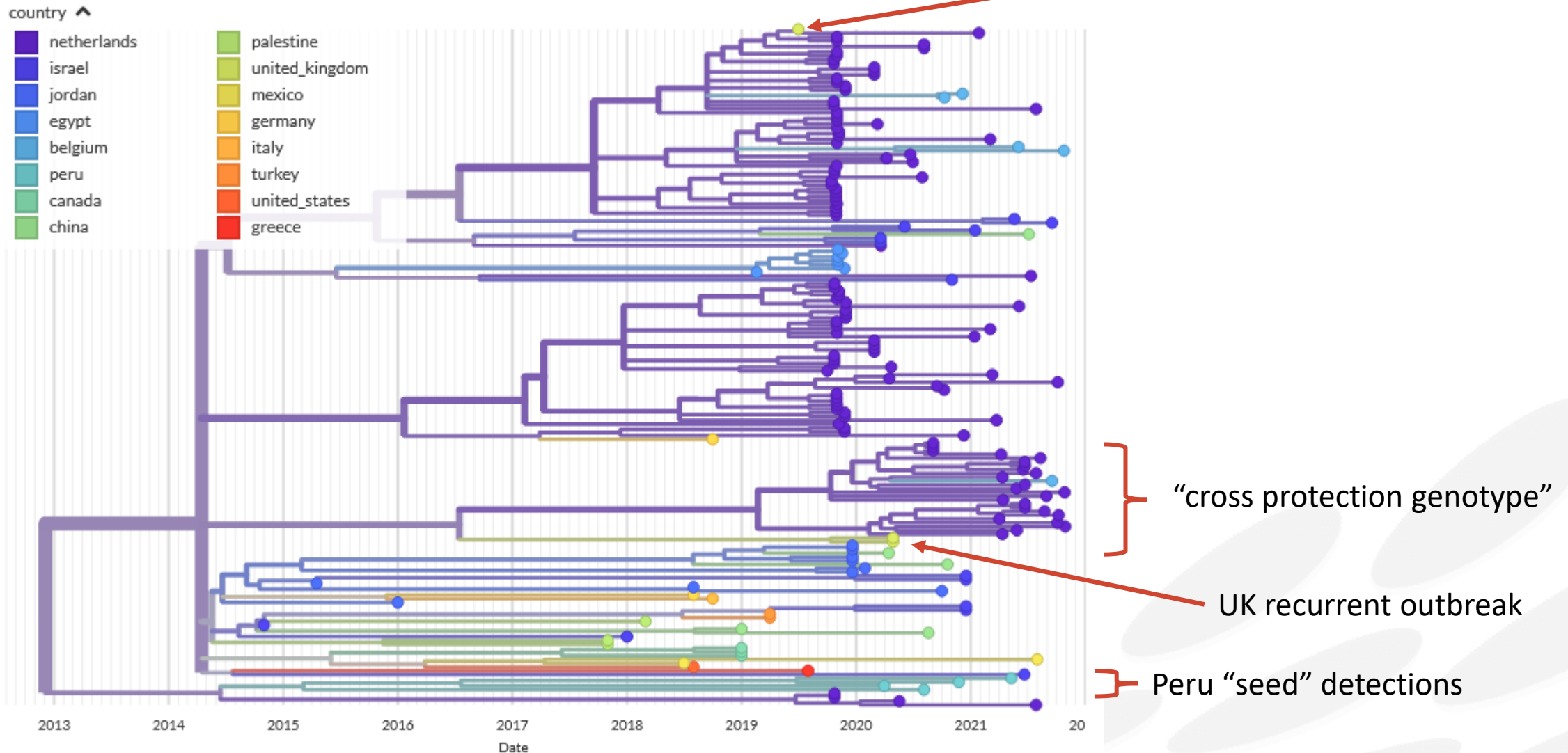


Colorado Beetle – linking findings

- Single colony found in a field and a lone male found nearby shortly after
- Microsatellite analysis used to determine kinship
- Results indicated that the lone male was not directly related to the colony.
- But further validation needed on repeatability and robustness of the markers.
- Alternative approach in progress – whole mtDNA genome sequencing.



Tracing the source of ToBRFV



Tracking UK outbreak sources by sequence?

“North” – Infection detected towards end of 2022 growing cycle.

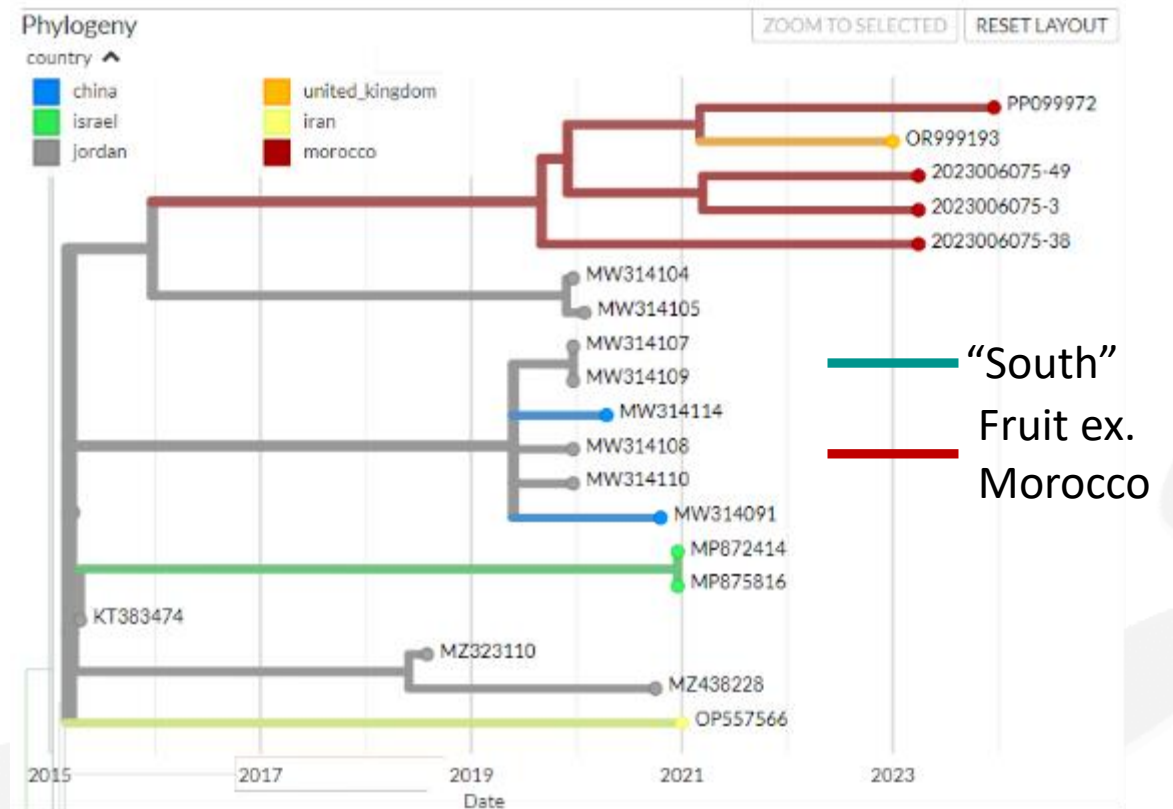
- **“cross protection” ToBRFV genotype**
 - (Not yet detected from seed)
 - Fruit origin?

“Midlands” - Ongoing re-infection since 2020.

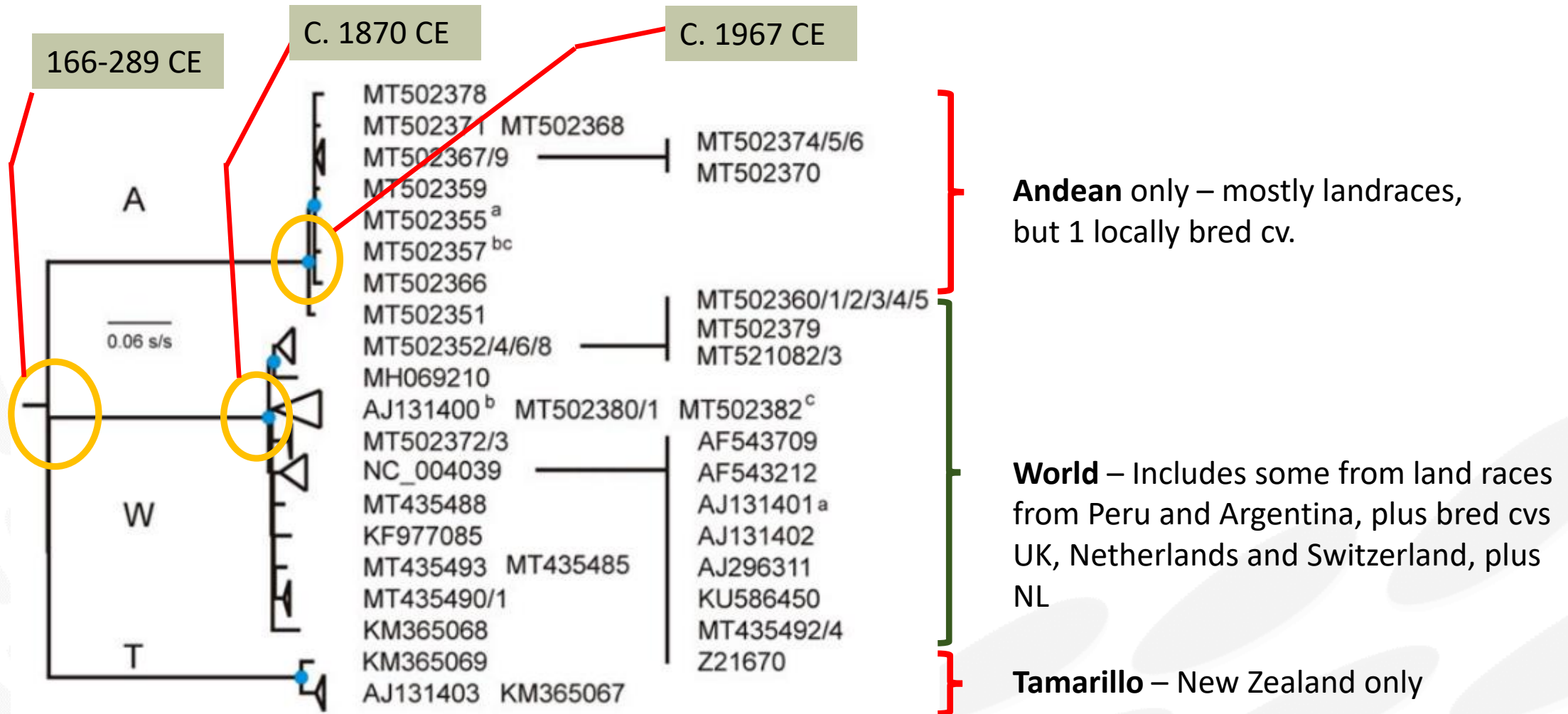
- **Grower identified packhouse staff moving to glasshouse as source of outbreak**
- Genotype in several European countries
- Fruit origin?

“South” – Infection early in 2023 growing cycle

- **Genotype similar to those from intercepted Fruit ex. Morocco**

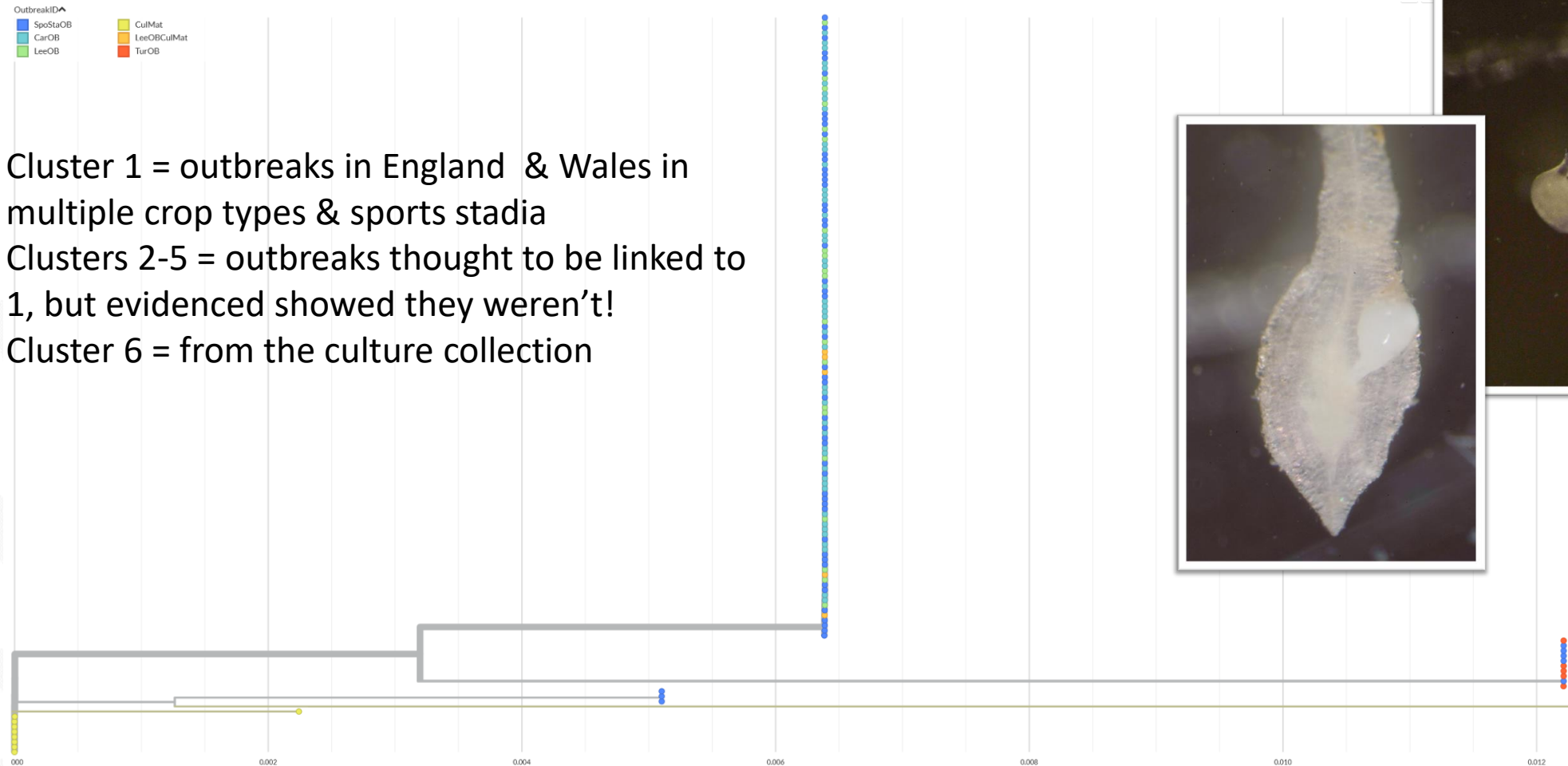


Potato virus A – European or non-European?



Fuentes S, Gibbs AJ, Adams IP, Wilson C, Botermans M, Fox A, Kreuze J, Boonham N, Kehoe MA, Jones RAC (2020) Potato virus A isolates from three continents: their biological properties, phylogenetics and prehistory, Phytopathology

Meloidogyne fallax – associating outbreaks

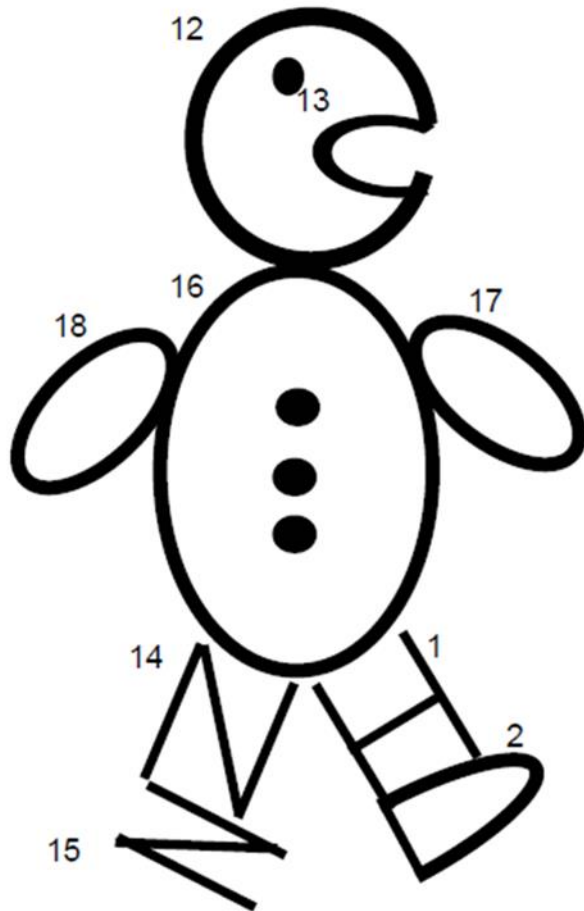


Asian Longhorn Beetle – establishing origins



Proof of principle work to investigate whether stable isotope analysis could be used to provide reliable information on the origin of the pest.

SIRA – stable isotope ratio analysis



Principal of SIRA_1 “you are what you eat”

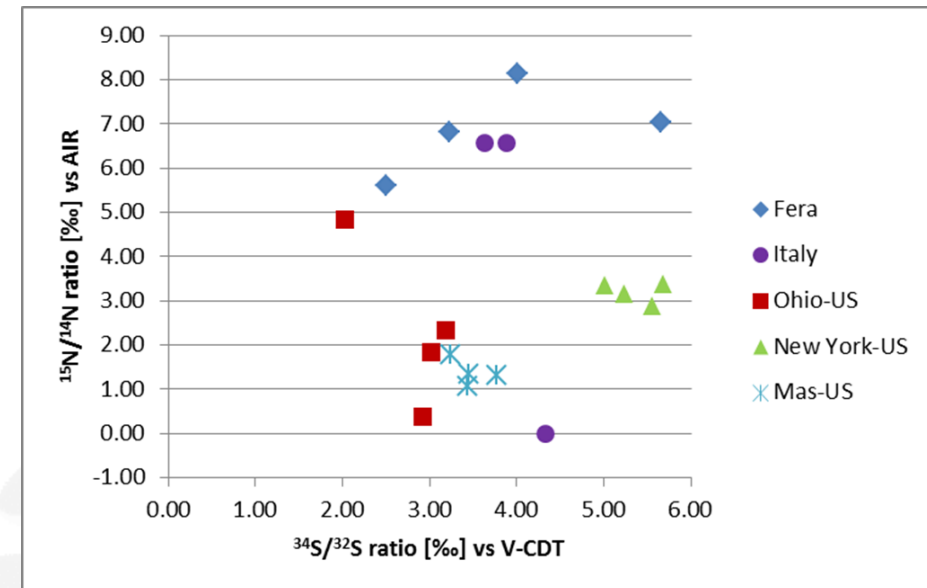
- Carbohydrates
- Lipids
- Proteins
- Water

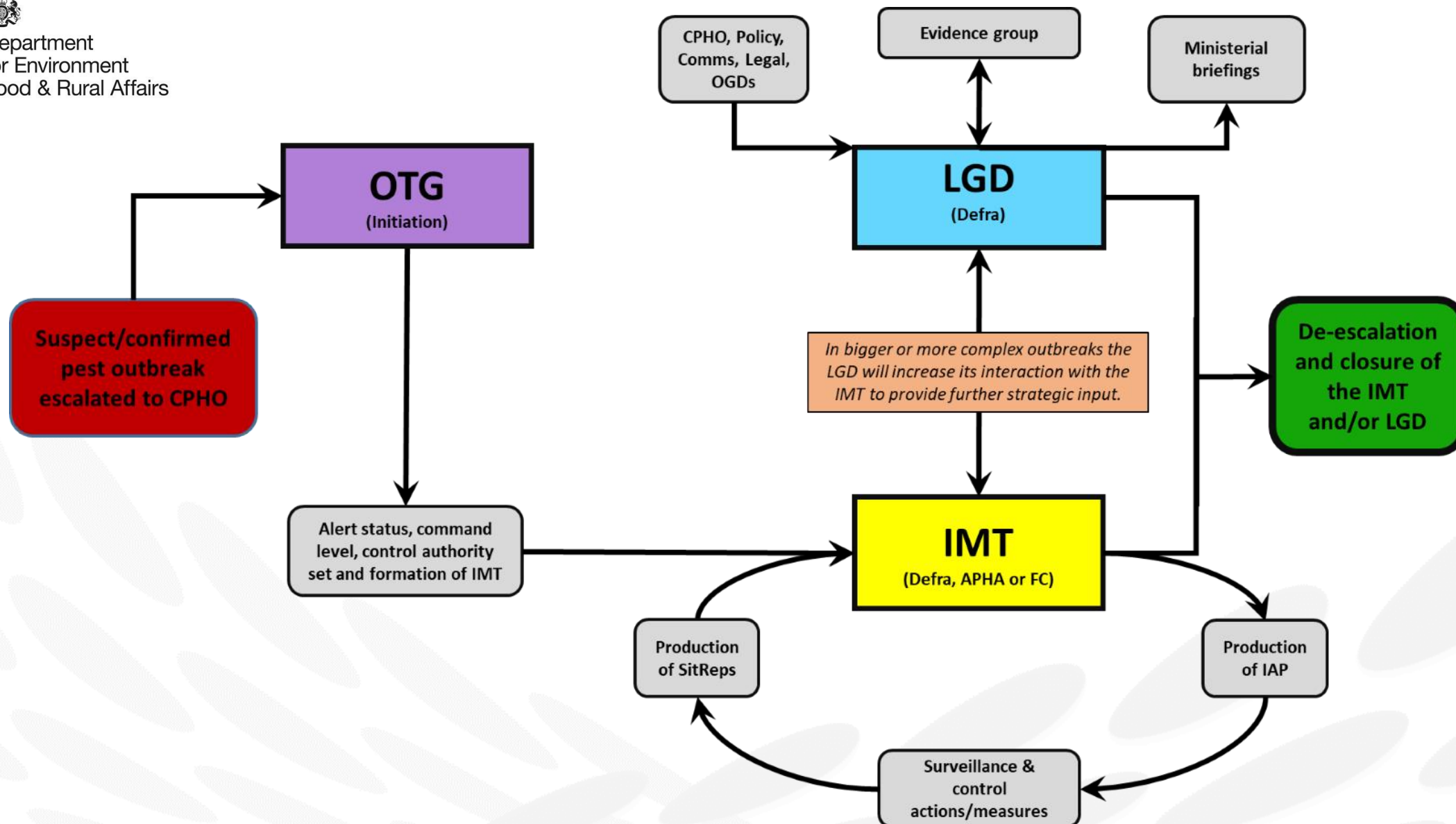
Stable bio elements: ^1H , ^2H , ^{12}C , ^{13}C , ^{14}N , ^{15}N , ^{16}O , ^{17}O , ^{18}O

Asian Longhorn Beetle – establishing origins



- Beetle legs are representative body parts
- Proof of principle demonstrated
- Differentiation of locations possible
- Analysis of further ALB samples required





In summary:

Every case is different
Communication is key
Asking the right questions
Context is everything

Thank you:

Eleanor Jones
Katharina Heinrich
Adrian Fox
Thomas Prior
David Crossley