EuroBlight

A potato late blight network for Europe

The evolving population of *Phytophthora infestans*; global context and consequences for IPM

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WAGENINGEN UR For quality of life

The James Hutton Institute

AARHUS UNIVERSITY

INRAE

James Moffat Duncan

Outline

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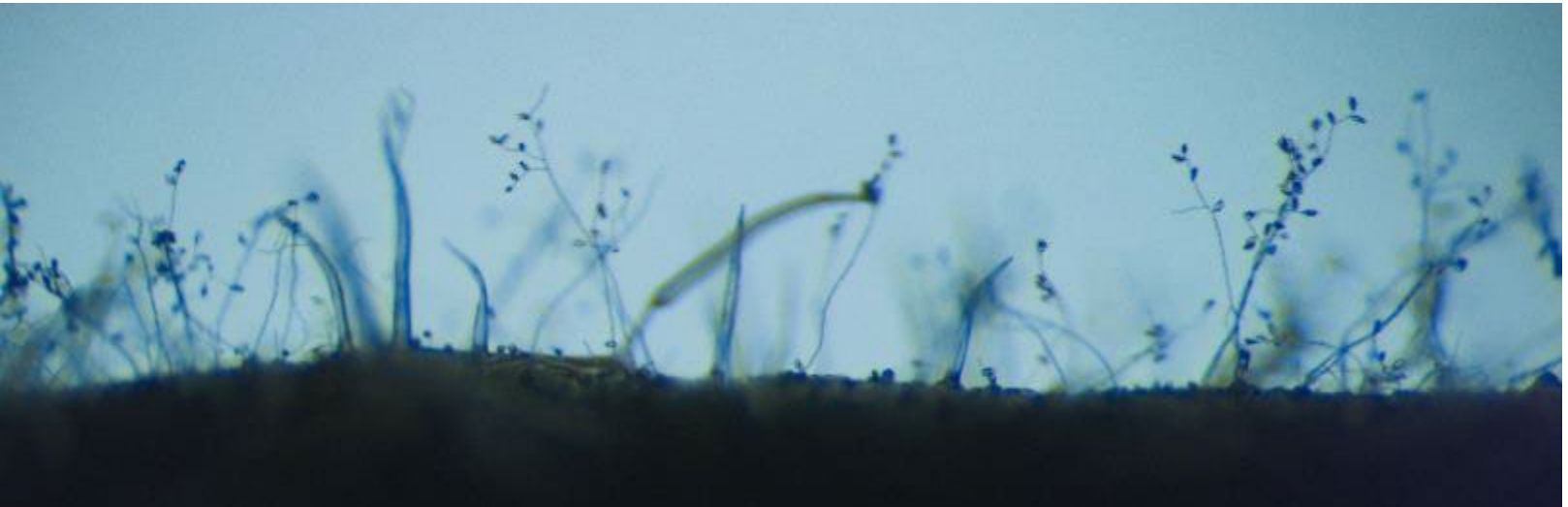
- The challenges
- Why monitor?
- Overview of 2021 European data – research focus
- Implications of recent population change
- Discussion/Questions



Challenges

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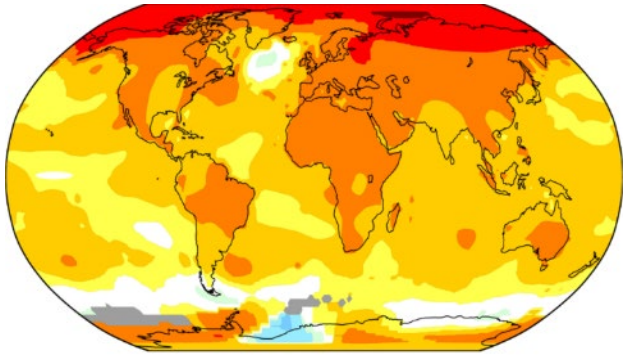
New blight – early attacks from oospores in the soil

- Highly diverse ‘Other’ oospore populations
- High genetic diversity increases risk from new virulence or fungicide resistance
- Predicting next lineages is difficult

Milder winters – inoculum from dumps and volunteers

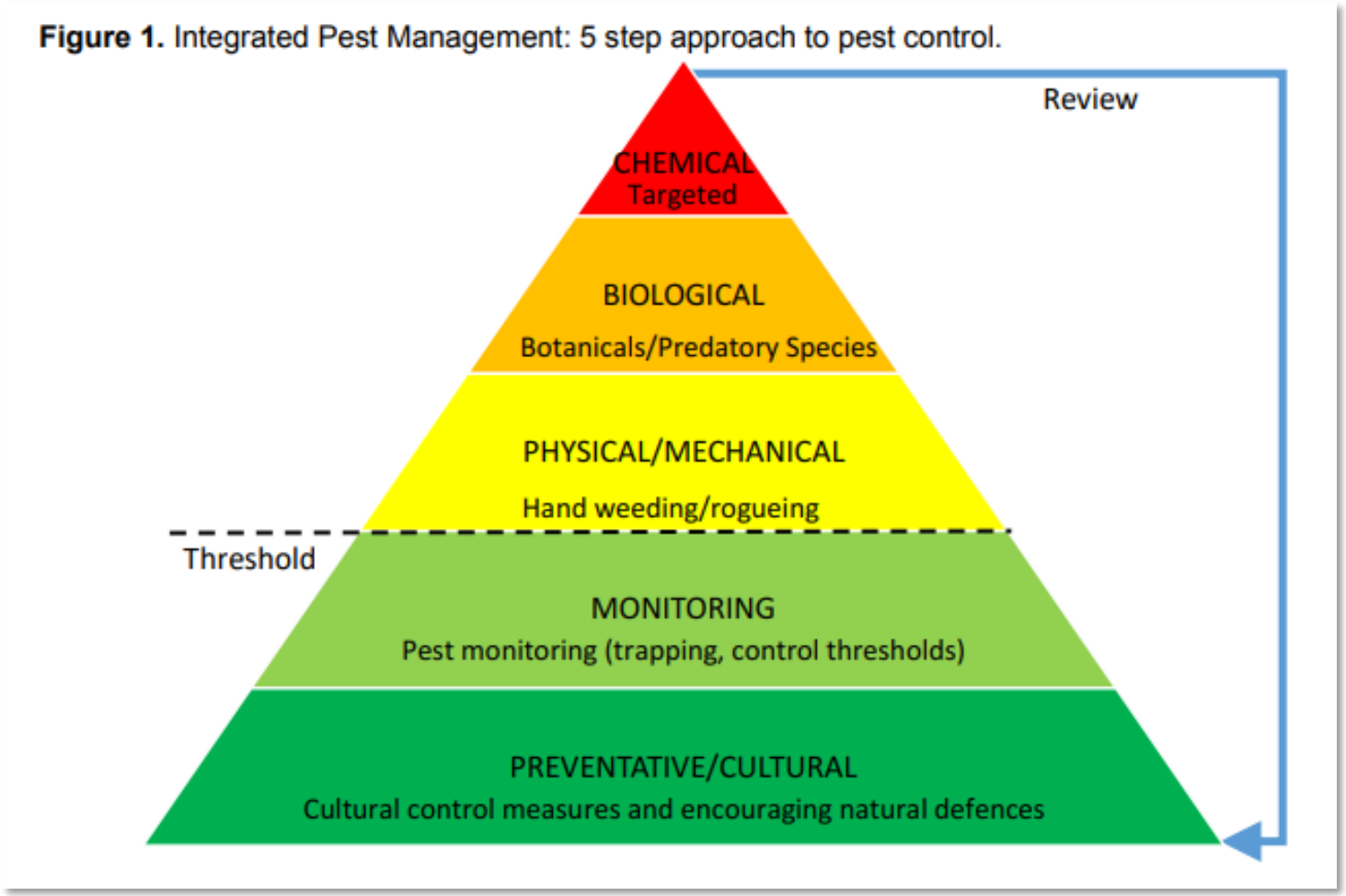


- Need for DSS to account for soil-borne inoculum
- Potential for earlier blight pressure
- Seed infection too

Demand for reduced fungicide use

- Increased focus on breeding blight resistance
- Understanding effector evolution
- Alternative products
- ECOSOL project

Why monitor?

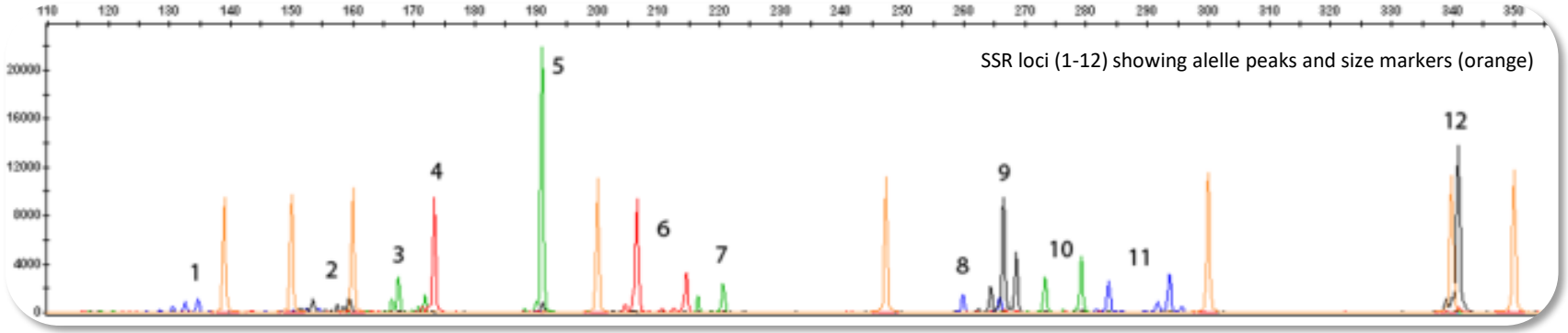


- Sustainable Use Directive (SUD)
- National Action Plans (NAPs) to reduce use of pesticides
- Use must be timely & effective
- Part of an IPM package
- Feedback to multiple stakeholders (growers, advisors, Agchem, breeders, FRAG, Levy boards)

UK 'Revised National Action Plan for the Sustainable Use of Pesticides'

Monitoring methods

- Scouts issued with sample forms and FTA cards (GB & FR live cultures collected)
- Outbreak data (e.g. location, crop type, cultivar) recorded
- Lesions pressed onto FTA cards to capture pathogen DNA
- DNA fingerprinted using 12-plex SSRs (Li *et al.* 2013)
  - Louise Sullivan at Hutton, UK
  - Romain Mabon & Michele Guibert at INRAE, FR
  - Dr Marta Janiszewska at IHAR, PL
- Genotypes defined & data stored in EuroBlight database
- Data publicly mapped on www.euroblight.net



Sample statistics (2013-2021)

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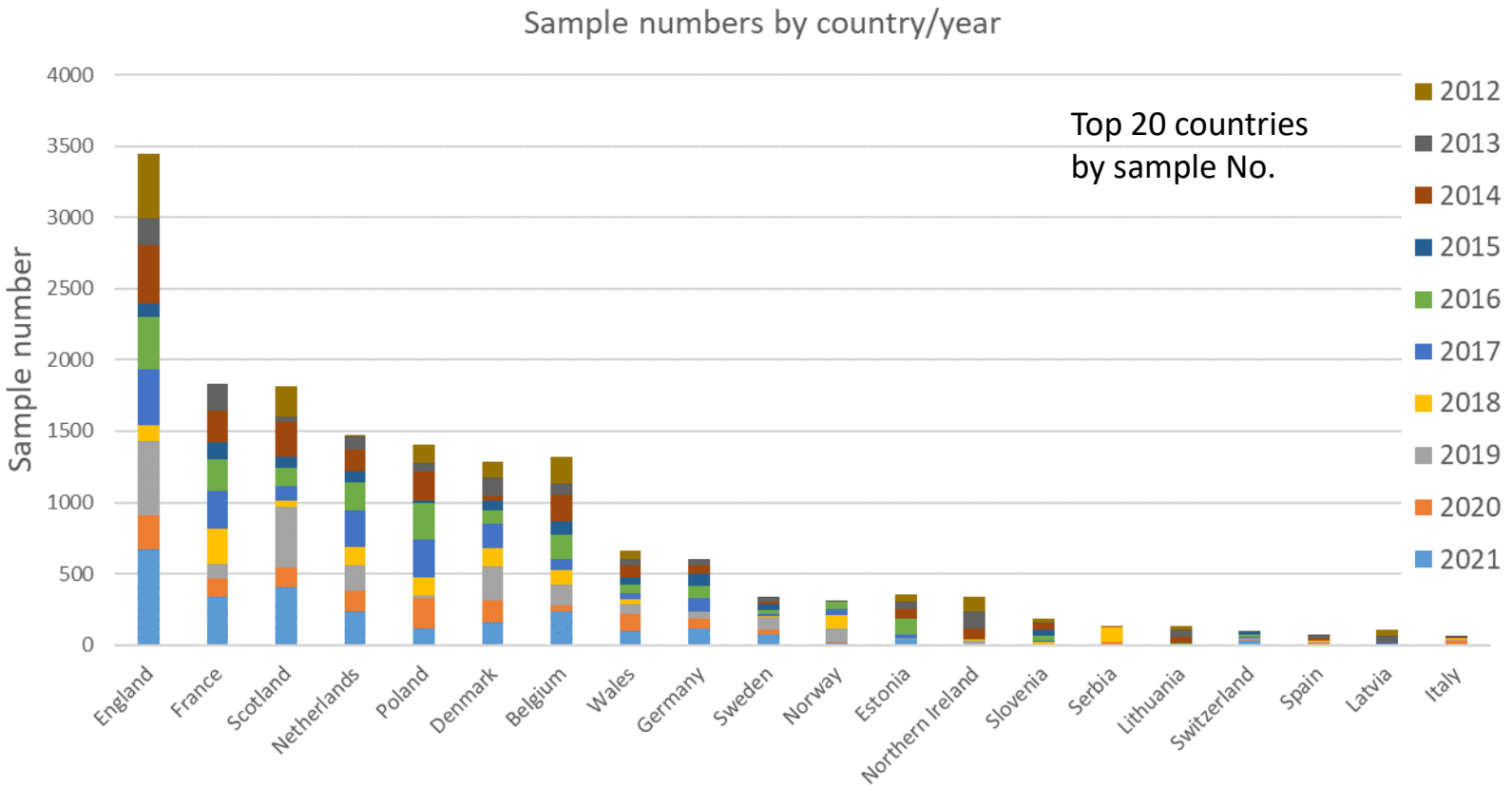
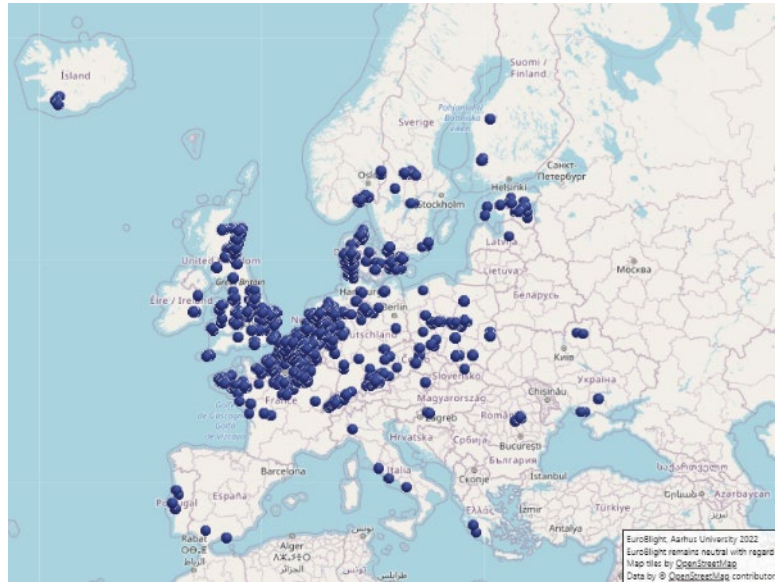


- Total 15K samples from 37 countries
- Northwestern Europe most sampled
- Long ‘tail’ of countries with relatively few samples
- 35% of samples from Great Britain (EN, SC, WA) – beware sampling bias



Europe 2021 data

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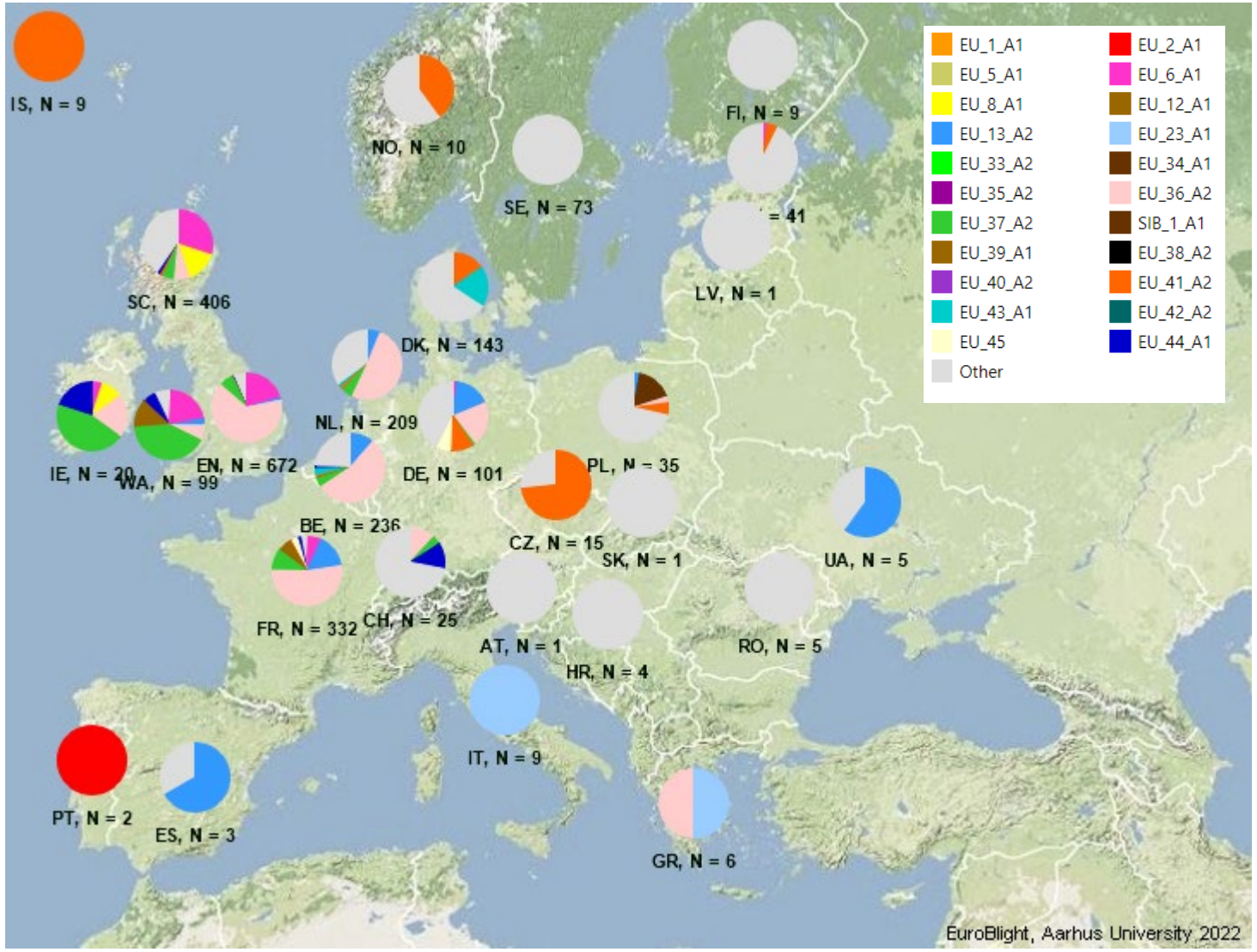
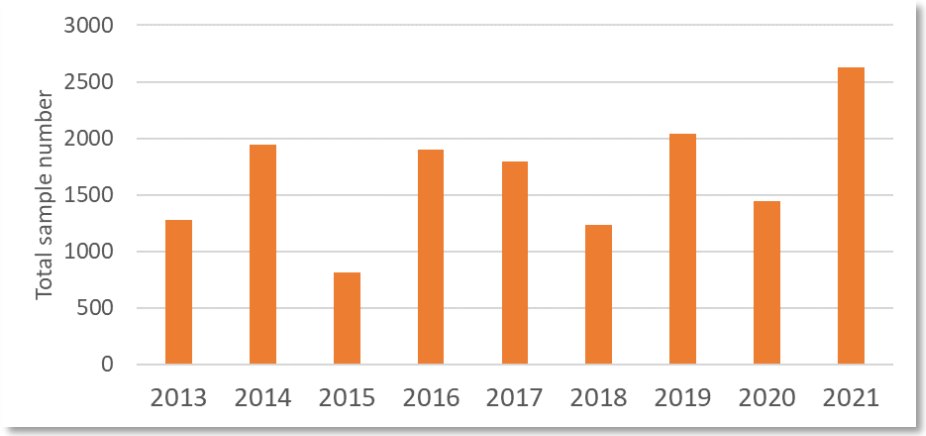


- 2021 – higher than average disease incidence
- 2600 samples - record number
- EU_13_A2 clone reduced markedly
- Other clones clustered and some spreading
  - EU_6_A1 UK, IE and France
  - EU_36_A2 increase
  - EU_37_A2 stable
  - EU_41_A2 decline but increased range
  - EU_23_A1 limited to southern Europe
  - Some new clones
- Higher proportion of ‘Other’ types in northern and eastern Europe



2013-2021 summary

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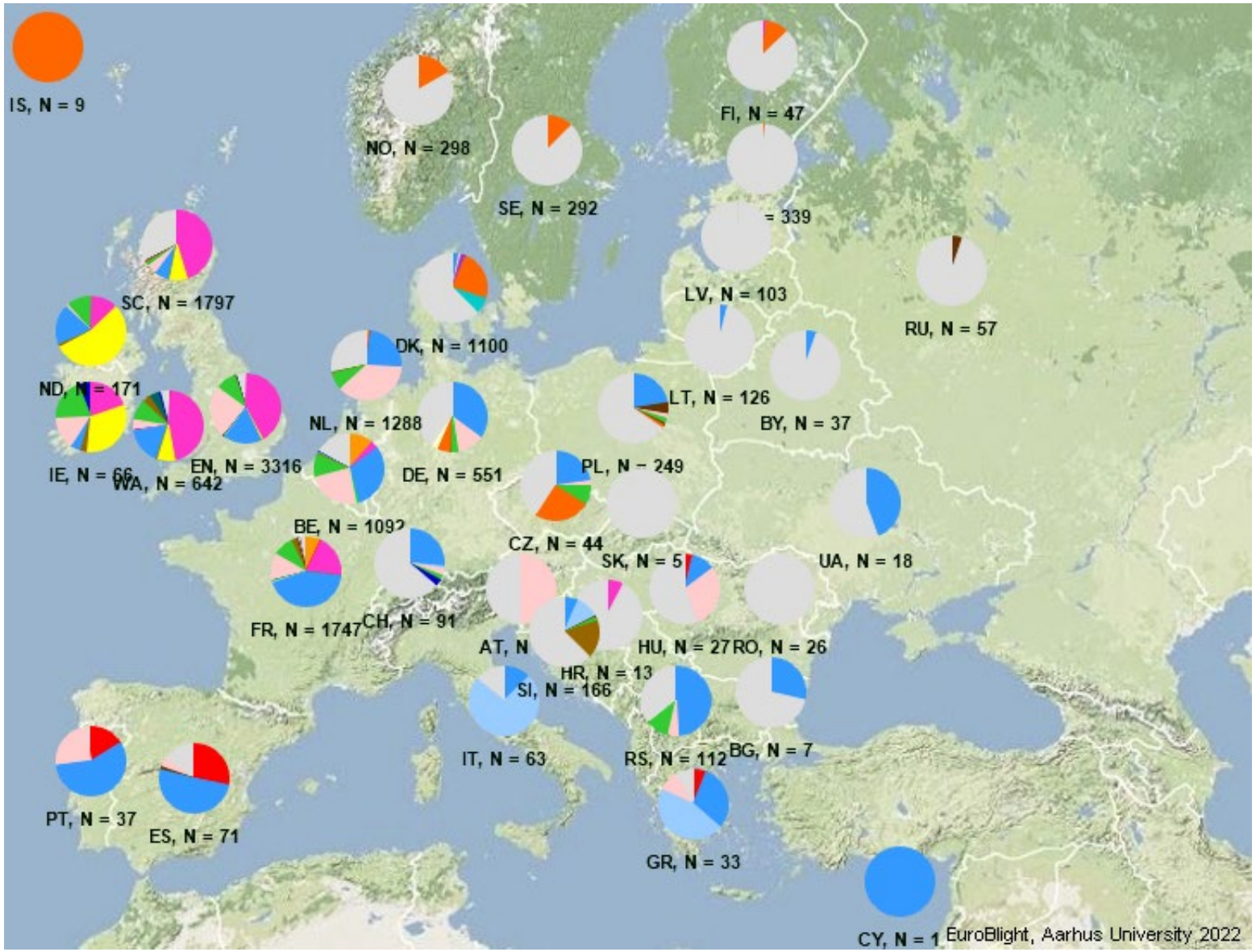

- Long-term trend of dominant clones observed in the west and south of Europe and 'Other' genetically diverse populations towards the north and east

EU_1_A1
EU_2_A1
EU_5_A1
EU_6_A1
EU_8_A1
EU_12_A1
EU_13_A2
EU_23_A1
EU_33_A2
EU_34_A1
EU_35_A2
EU_36_A2
EU_37_A2
SIB_1_A1
EU_39_A1
EU_38_A2
EU_40_A2
EU_41_A2
EU_10_A2
EU_22_A2
EU_3_A2
EU_43_A1
EU_42_A2
EU_45
EU_44_A1
Other

Europe *P. infestans* genotype change

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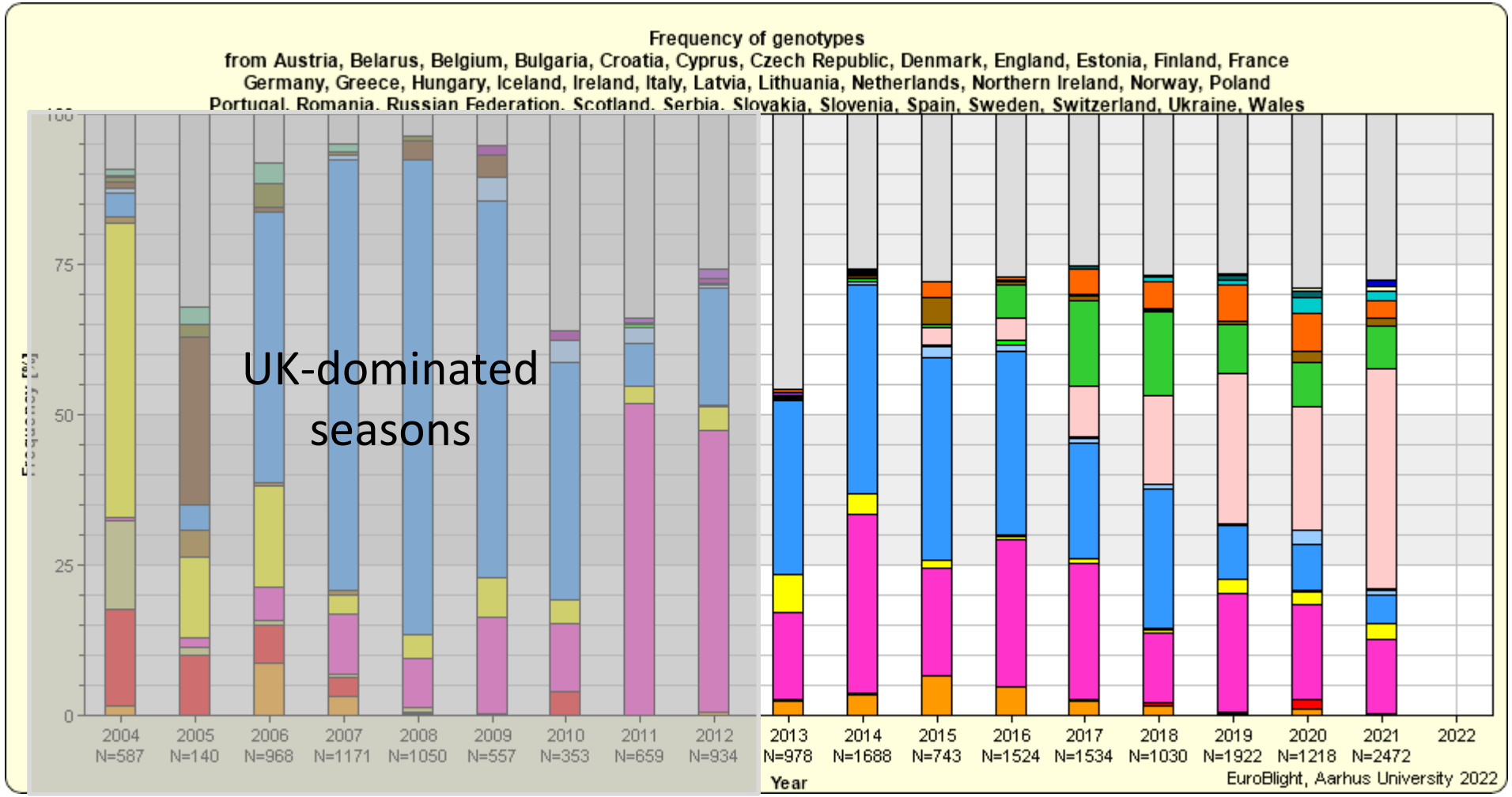

https://www.euroblight.net/

Europe *P. infestans* 2021 headlines

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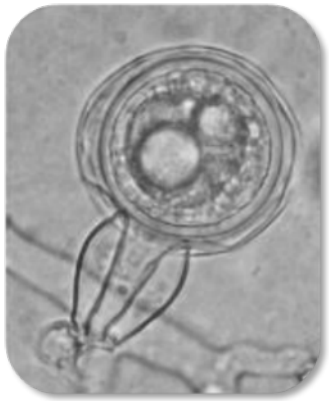
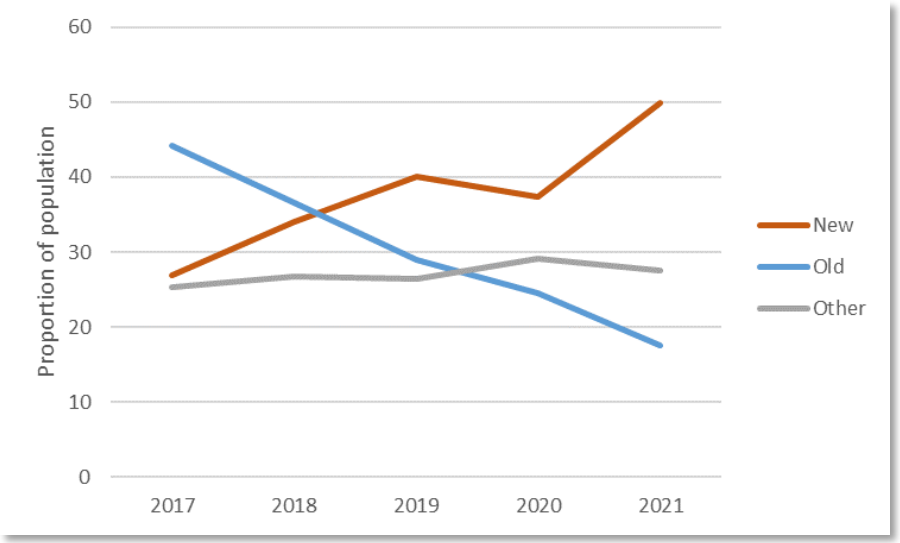
- Recent clones
  - EU_43_A1 overall decline & EU_42_A2 (GB) disappeared
  - EU_44_A1 (many countries) & EU_45_A1 (DE & FR)
- EU_13_A2 decline continues from 9.3% in 2019, 7.6% in 2020 & 4.9% 2021
- EU_36_A2 rose from 20.8% in 2020 to 36.7% in 2021
- EU_37_A2 stable at 7.4% in 2020 and 7.0% in 2021 – locally variable
- EU_41_A2 fallen from 6.4% in 2020 to 2.9% in 2021
- EU_6_A1 fallen 15.8% in 2020 to 12.5% in2021 mainly in FR, UK and Ireland



- Older (6_A1, 13_A2, 1_A1) decline to 17.5% of 2021 population
- Newer (36_A2, 37_A2, 41_A2, 43_A1, 44_A1, 45_A1) increase to 50% of 2021 population
- Abundance of clones shows high proportion of inoculum overwinters in tubers
- Proportion of 'Other' genotypes stable over time: probably from oospores



Europe *P. infestans* - Tomato

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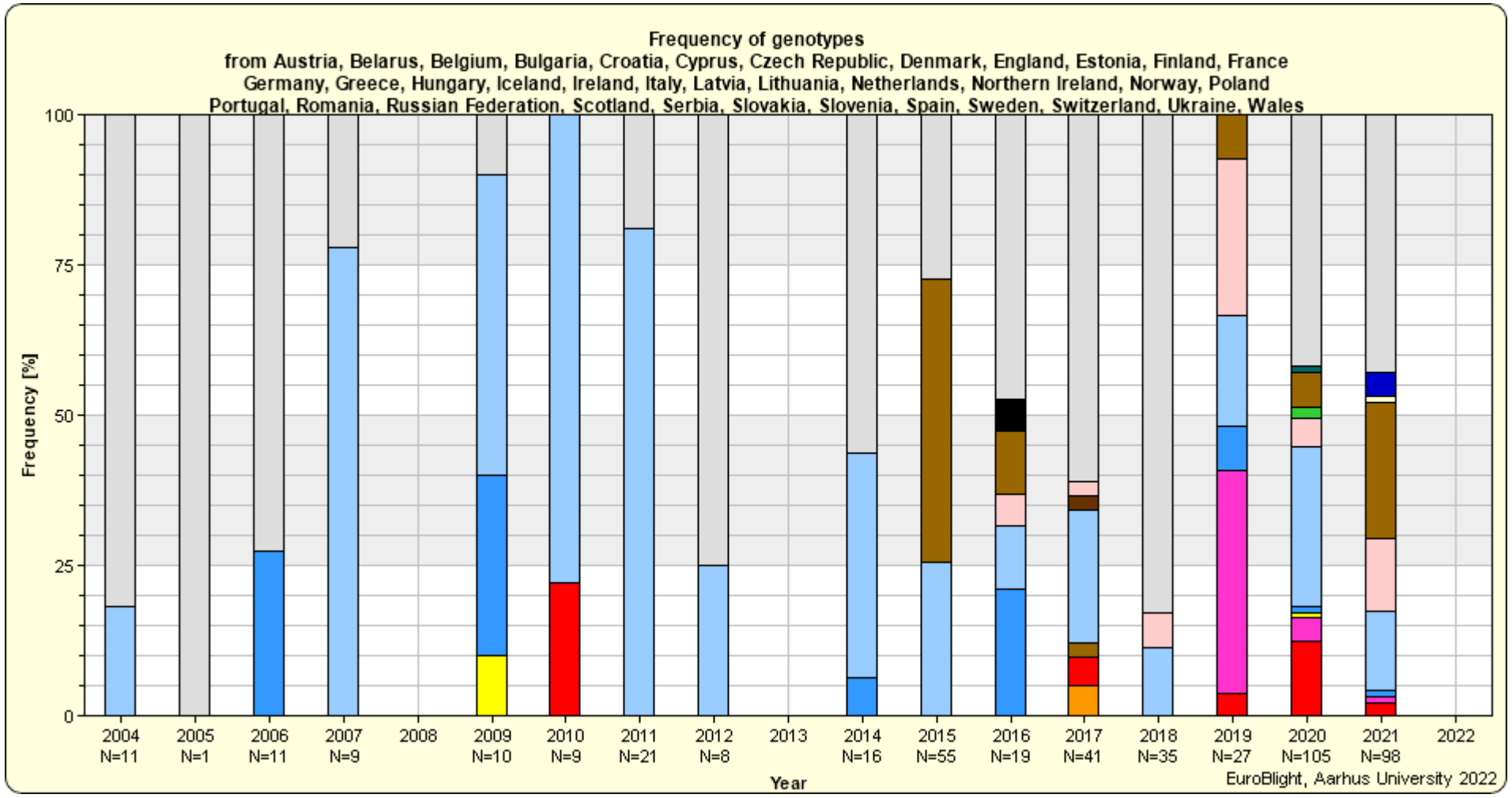

- Tomato pathogen population largely distinct from potato
- Weed hosts (Nightshade) share types with potato

EU_1_A1
EU_2_A1
EU_5_A1
EU_6_A1
EU_8_A1
EU_12_A1
EU_13_A2
EU_23_A1
EU_33_A2
EU_34_A1
EU_35_A2
EU_36_A2
EU_37_A2
SIB_1_A1
EU_39_A1
EU_38_A2
EU_40_A2
EU_41_A2
EU_10_A2
EU_22_A2
EU_3_A2
EU_43_A1
EU_42_A2
EU_45
EU_44_A1
Other

2021 all samples

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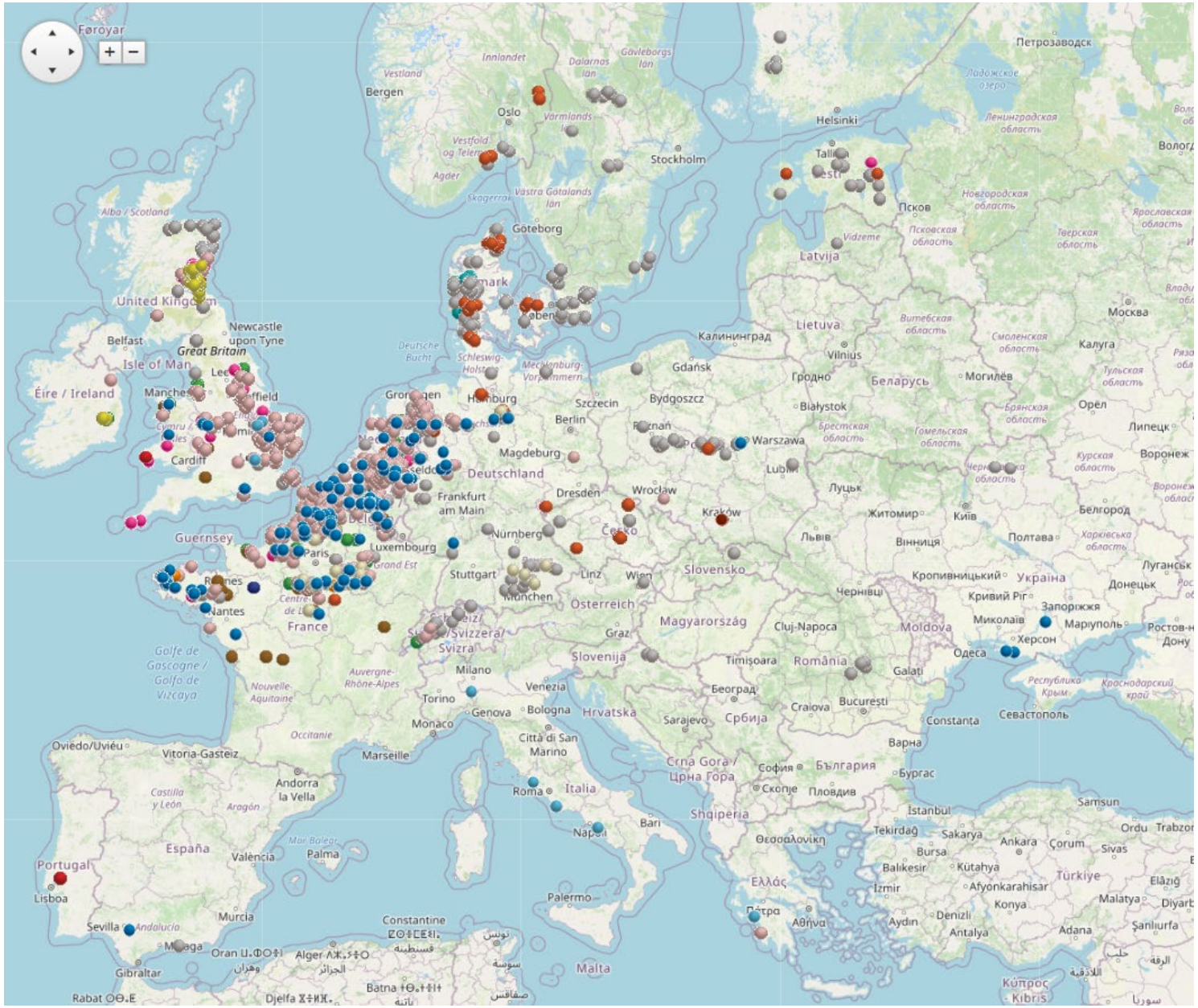

- 2492 genotyped samples from 27 countries
- Some regions sampled more intensely than others

2020 all samples

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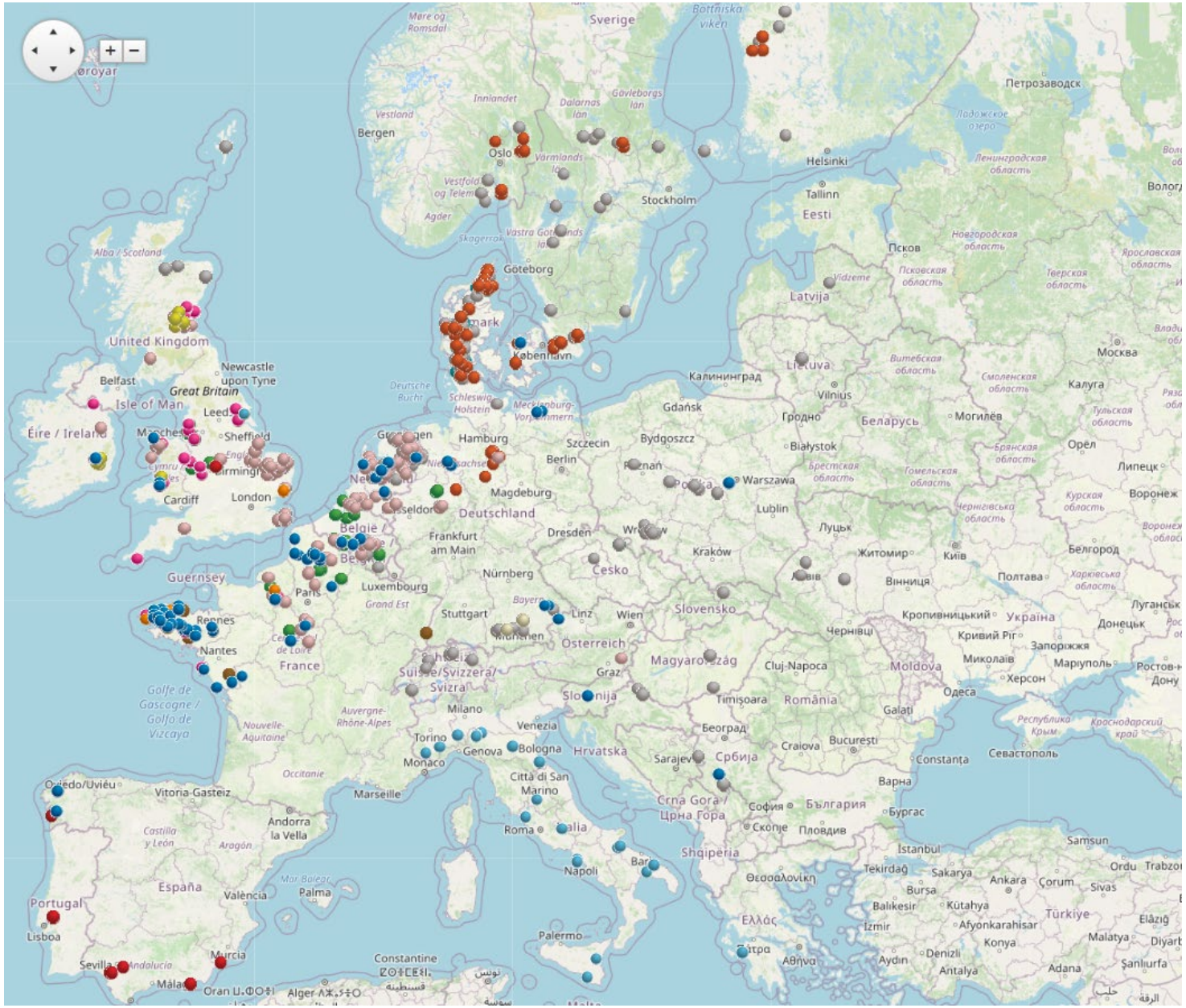

- 1200 genotyped samples from 28 countries
- Less intense sampling in drier summer than 2021

Evolution & spread of recent clones: EU41 & EU43

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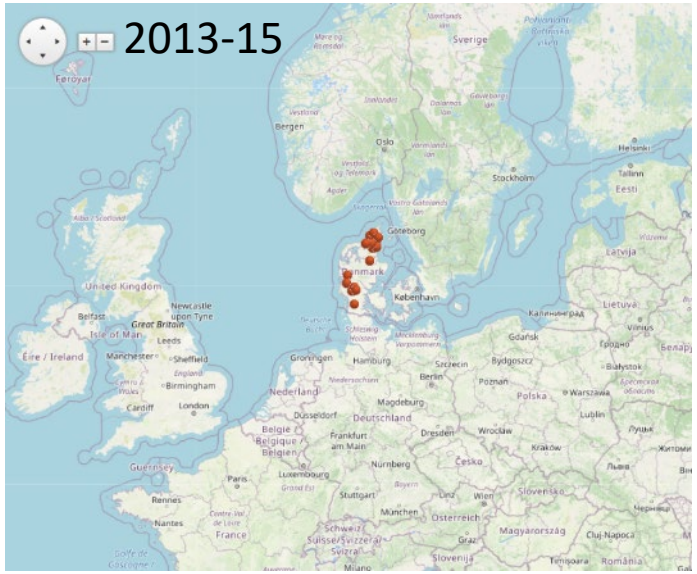
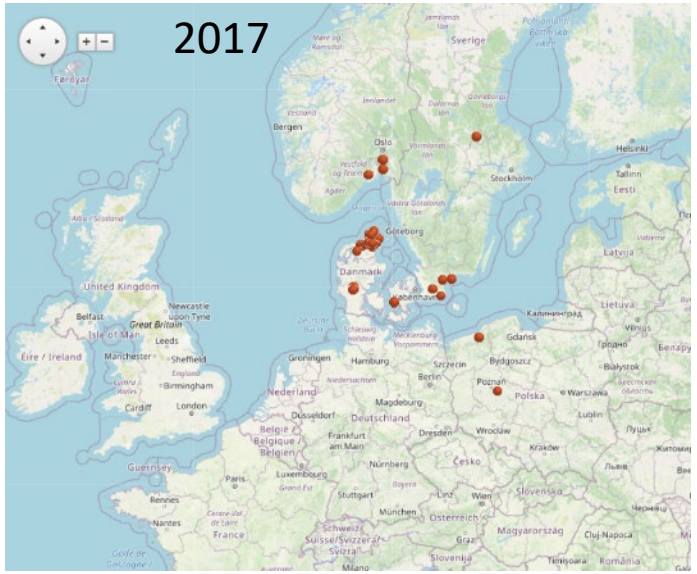
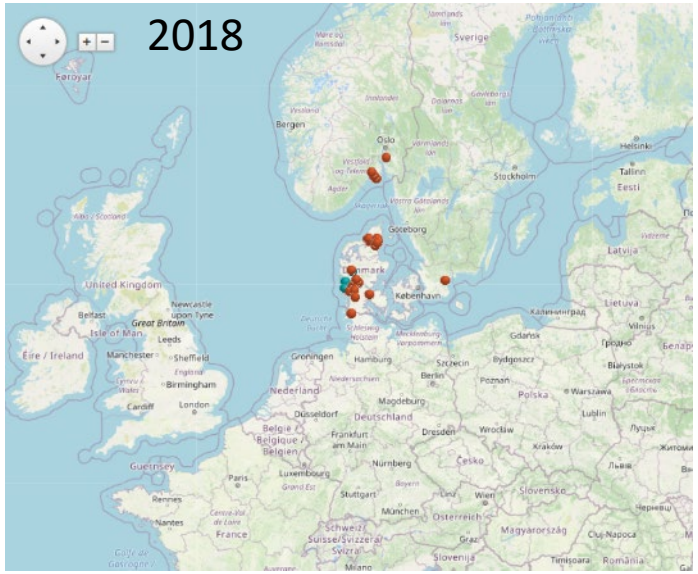
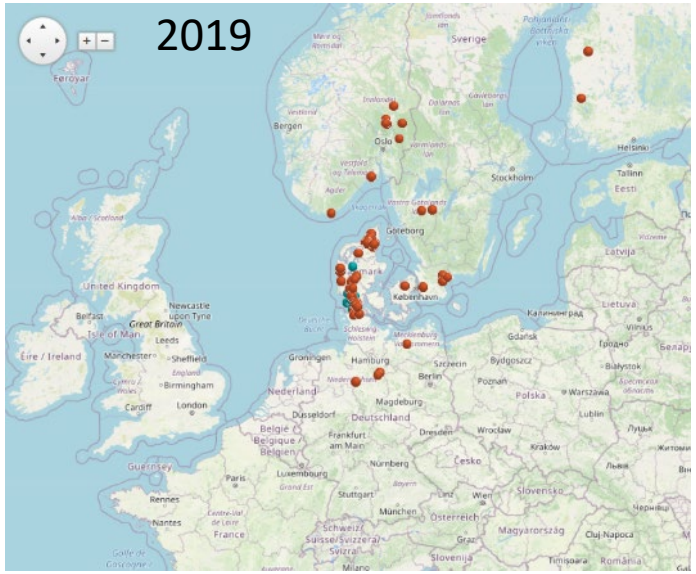
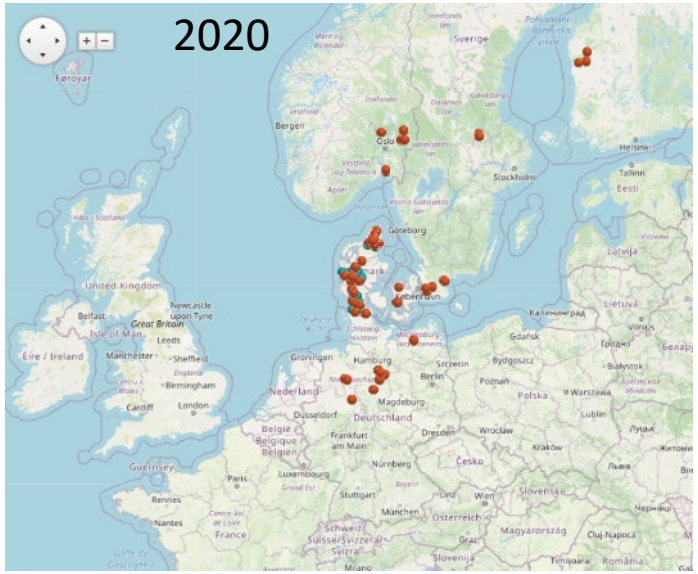




EU41 spread to 6 countries by 2020







EU43 only in DK from 2018 onwards

2021 EU_41_A2 and EU_43_A1 range expansion

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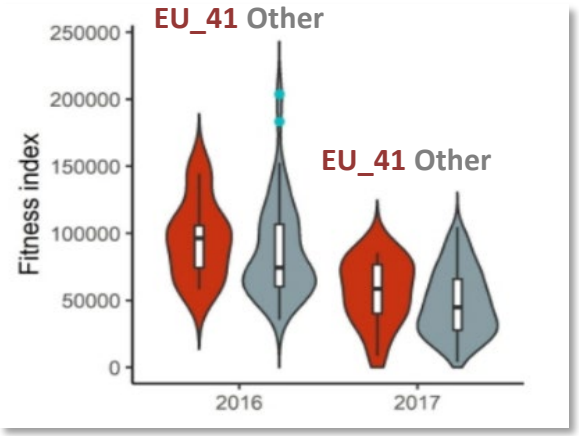
Iceland had severe blight

- Overall **EU_41_A2** & **EU_43_A1** declined but range expanded to west, south and north
- Method of spread?
  - Seed/wind or both?
- Selection pressure?
  - Fungicide sensitivity
  - Fitness, agress.
- Publication on **EU_41**
  - no single clear factor
  - Virulence perhaps



Puidet B, Mabon R, Guibert M, Kiiker R, Soonvald L, Le VH, Eikemo H, Dewaegeneire P, Saubeau G, Chatot C, Aurousseau F, Cooke D, Lees AK, Abuley I, Hansen JG, Corbiere R, Leclerc M, Andrivon D, 2022. Examining phenotypic traits contributing to the spread in northern European potato crops of EU_41_A2, a new clonal lineage of *Phytophthora infestans*. *Phytopathology* 112, 414-421. *IPM BLIGHT 2.0 Publication*

2021 Two new clones

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- EU_45_A1 clone found in Bavaria in 2019 and 2020 & more widespread in 2021
- Limited isolates of EU_45_A1 available

- **EU_44_A1** first found in 2021 but unexpectedly widespread over a 1200 km radius. Perhaps spread via seed in 2020 and not sampled due to drier summer?
- No information yet available about the traits of either clone

2021 36_A2 samples

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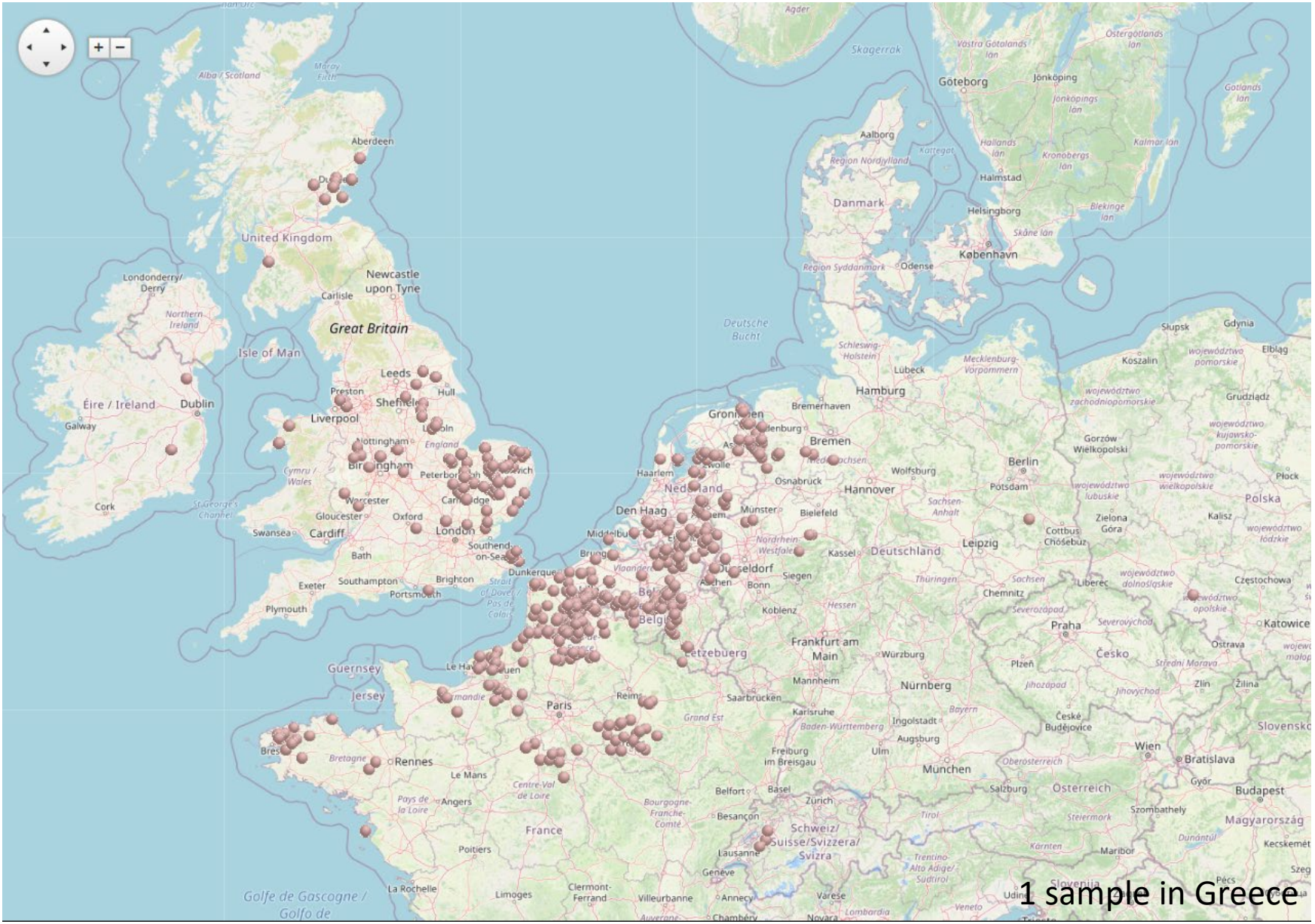

1 sample in Greece

- Highest frequency yet of 36_A2 at 37%
- Almost 1000 samples and over 100 sub-clonal variants
- Intensely sampled in north-western regions but why not competitive in north and east Europe?

2021 37_A2 samples

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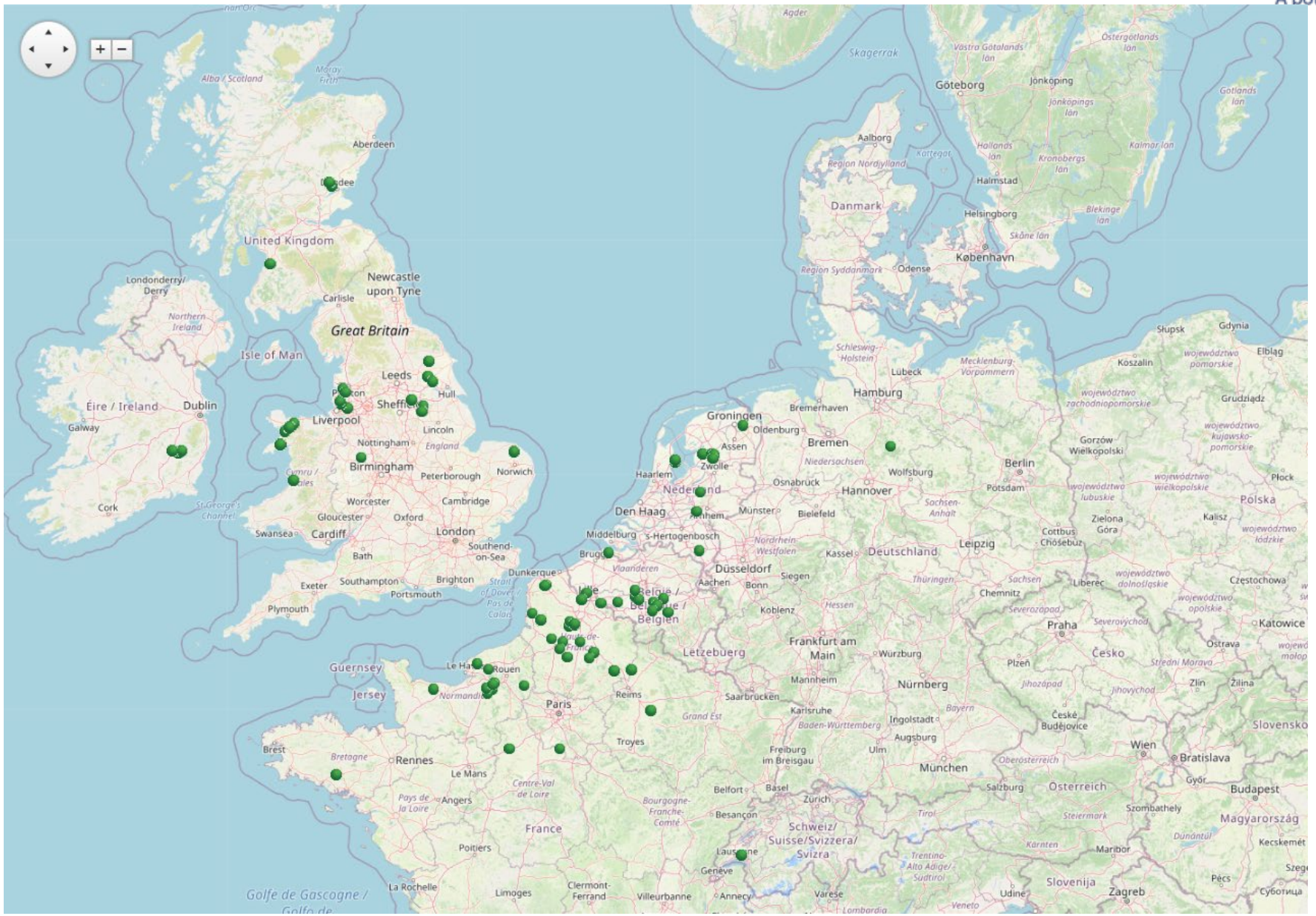

- 37_A2 population has insensitivity to fluazinam
- Proportion stable at 7-8% over past 3 years
- Less competitive than other clones in absence of fluazinam so perhaps some selection where fluazinam still used?

2021 13_A2 samples

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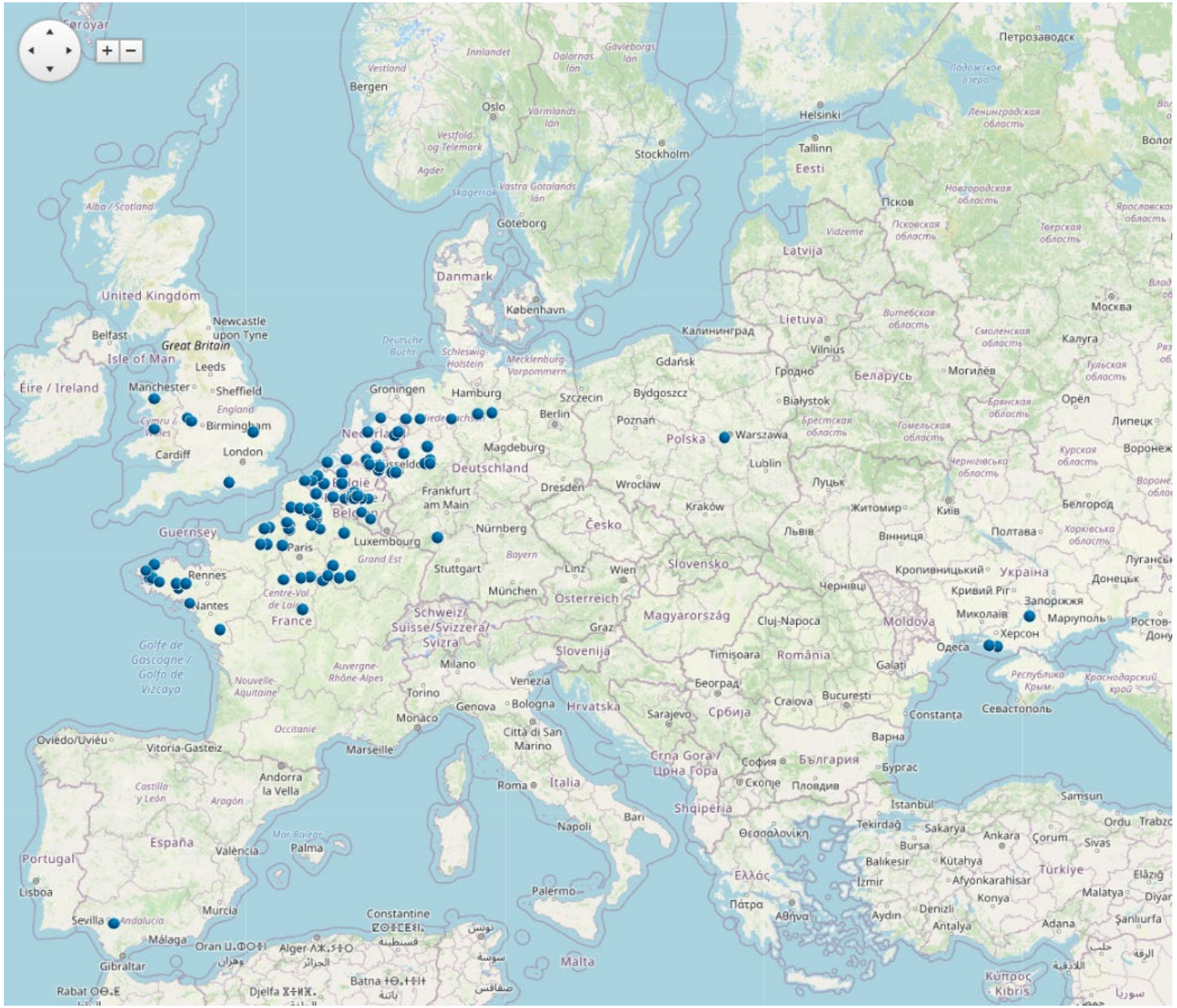
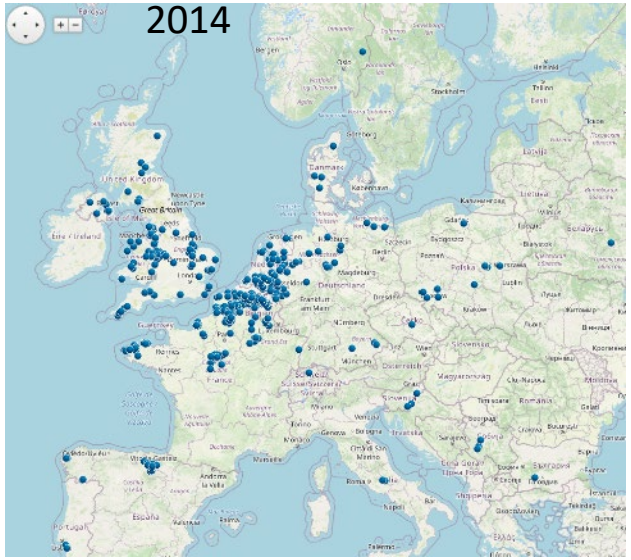


- 13_A2 still sampled but a continual declining proportion less than 5% compared to 35% in 2014
- Still prevalent in other parts of the world
- Metalaxyl use resume?

2014



2021 6_A1 samples

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- 6_A1 locally dominant but proportion declined to 12%

2021 ‘the rest’ of the known clones

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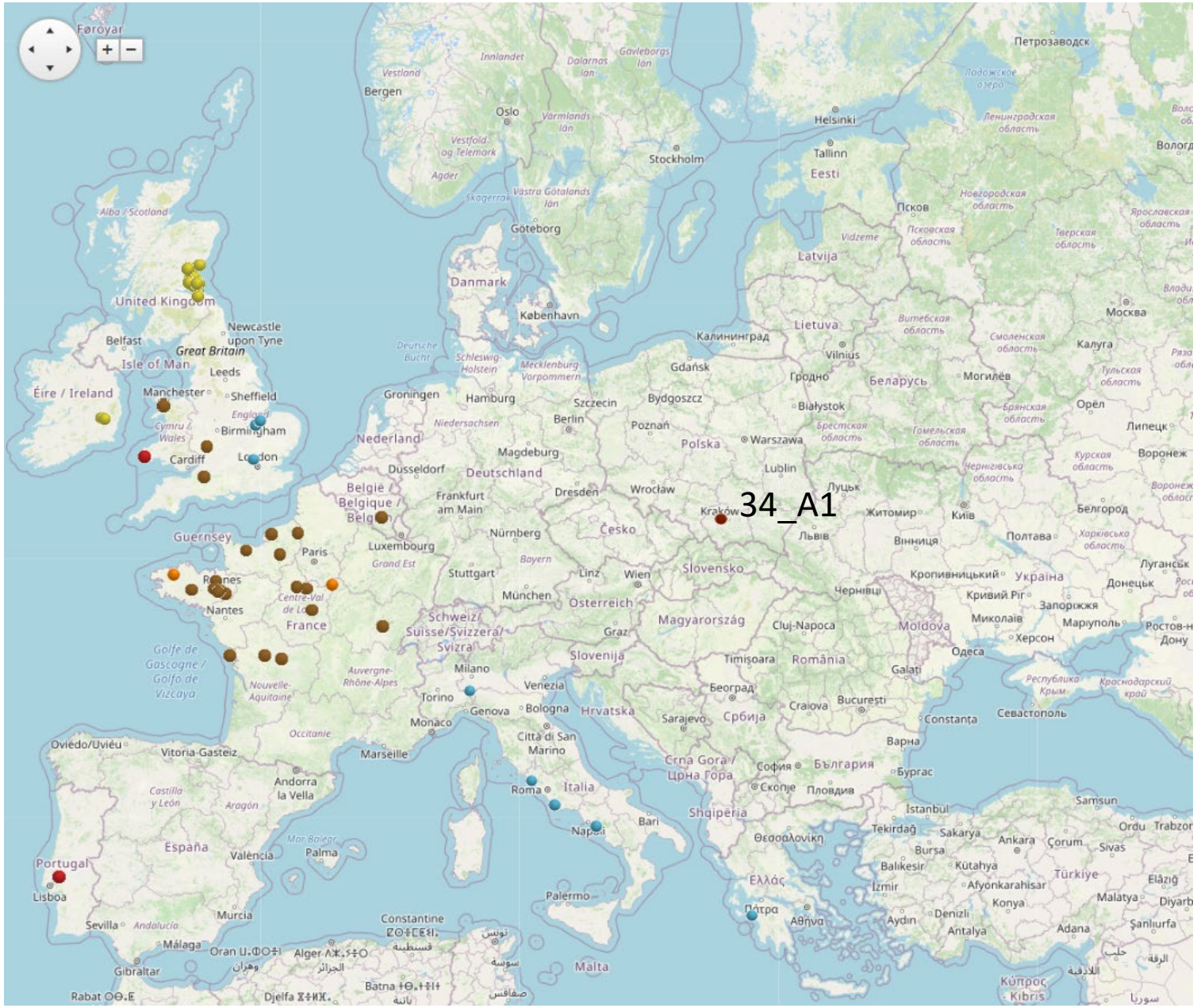

- 8_A1 local to Scotland and Ireland
- 39_A1 FR, BE, UK mostly tomato
- 2_A1 widespread older lineage now restricted in Europe (PT, ES)
- 23_A1 IT, GR, EN Tomato-adapted
- 1_A1 severe decline since 2014 high (6.5% - mainly BE and FR)
- 34_A1 former East sample but only 1 in PL

Saville AC, La Spada F, Faedda R, et al., 2021. Population structure of *Phytophthora infestans* collected on potato and tomato in Italy. Plant Pathology 70, 2165-78.

Pettitt TR, Keane GJ, John SOL, Cooke DEL, Žerjav M, 2019. Atypical late blight symptoms following first recorded infections by *Phytophthora infestans* genotype EU_39_A1 in UK vine tomatoes. New Disease Reports 39, 16.

2021 Other samples

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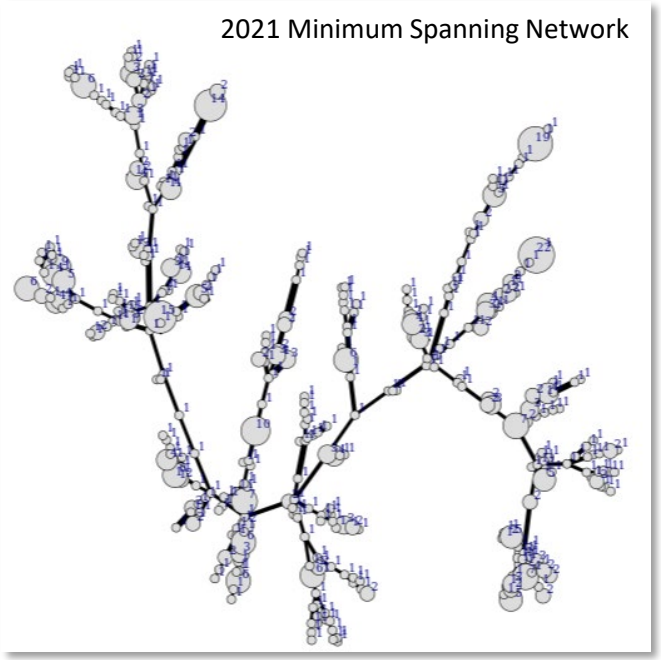
- 687 Other samples. High genetic diversity
- Some local in-field clusters
- No carry-over from one season to the next
- Probably oospore-borne inoculum



Clones vs ‘Other’ phylogeny based on 2021 SSR data

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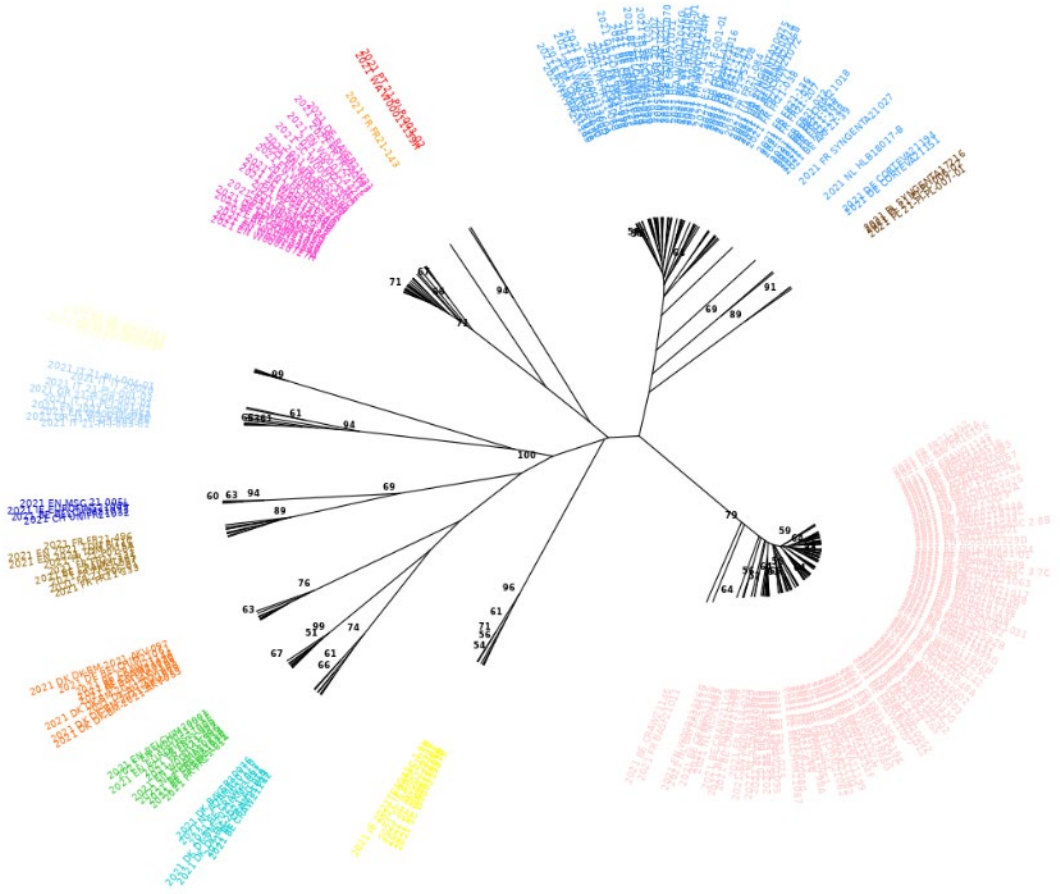
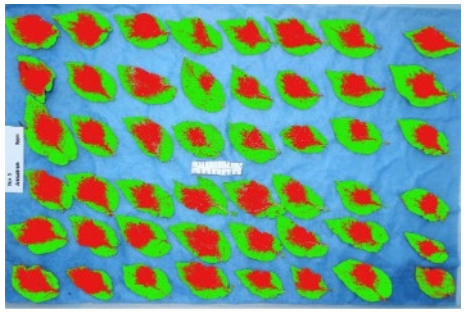


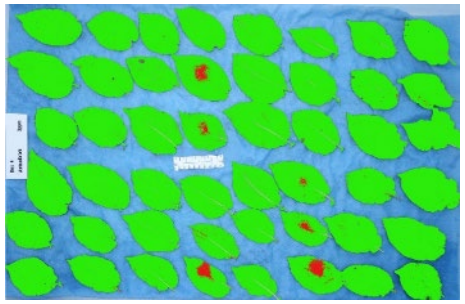
- Distinct clusters of genetically similar MLGs representing the major clones and their sub-clonal variants
- Long branches between clones reflect greater Bruvo distances

- Highly diverse
- Branches join deep in tree with no clear pattern
- No discrete clusters

Fungicide testing

FRAC Group	Active ingredient	Product	Full UK dose (ppm)	Year Tested
QiI (21)	Cyazofamid 160g/l	Ranman	400	19,20,21
QiI (21)	Amisulbrom 200g/l	Shinkon	200	19,20,21
CAA (40)	Mandipropamid 250g/l	Revus	750	19,20,21
Carbamates (28)	Propamocarb 720g/l (625g as Infinito)	Promess	5000	19,20,21
Benzamides (43)	Fluopicolide 5mg/ml (62.5g/l as Infinito)	Pure active (Sigma Aldrich)	500	19,20,21
OSBPI (49)	Oxathiapiprolin 100g/l	Zorvec	75	19,20,21
Dithiocarbamates (M03)	Mancozeb 750g/kg	Penncozeb	6375	19,20,21





- Five contemporary isolates each of 6_A1, 36_A2 and 37_A2 tested *in vitro* against dose range of seven a.i. Hutton Institute (AHDB Potatoes funding) over years 2019, 2020 & 2021
- No evidence of change in sensitivity to any active ingredient tested in any genotype over 3 years
- Minor differences in some a.i./genotype combinations but all at very low doses significantly below field rates
- Reduced sensitivity of 37_A2 to fluazinam confirmed in published (Schepers et al., 2018) and unpublished studies
- 36_A2 sensitive to Mefenoxam (data kindly shared by Yigal Cohen, Bar-Ilan University, Israel

OPEN & TIMELY REPORTING CRITICAL TO MANAGE BLIGHT WITH RESTRICTED RANGE OF ACTIVES

Alison Lees & James Lynott

EuroBlight in global context

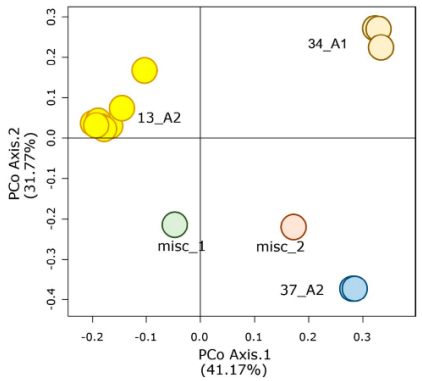
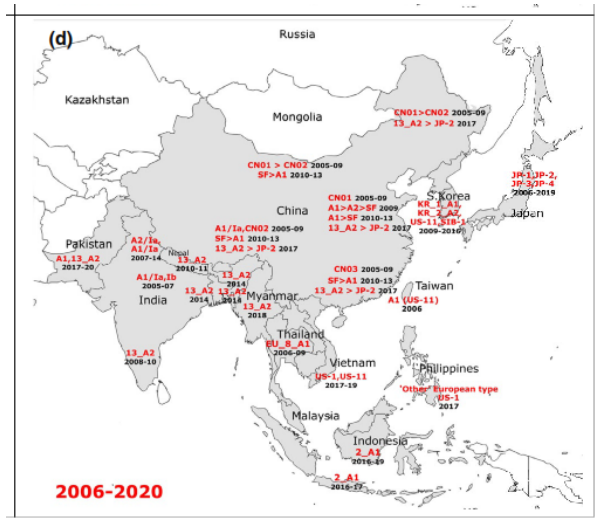


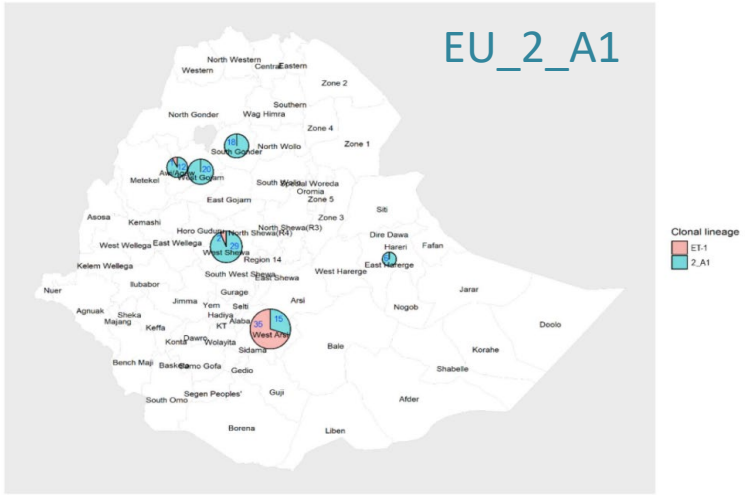
FIGURE 3 Principal component analysis of genotypes of *Phytophthora infestans* from Turkey based on data from analysis of simple-sequence repeat (SSR) markers (details of genotypes are given in Table 6)

Turkey – Gore *et al*



Guha Roy *et al* Review Asia

Journal of Plant Pathology



Ethiopia – Mihretu *et al*

- Asia minor – Turkey
- Asia – Review and new data
- Latin America – CIP, TIZON
- Africa – ET, NG,

- Conclusion is that Europe (mainly) exports its *P. infestans* clones and needs to share management practice data to help IPM

Conclusions

- Europe-wide dataset - valuable insights on pathogen diversity
- Dominance of a few clones across large areas of European crops - growers/industry share management challenges
- New clones (36_A2, 37_A2, 41_A2, 43_A1) established and displacing older genotypes (13_A2, 6_A1 and 1_A1)
- Spread of lineages 41_A2 and 43_A1 to low countries in 2021

- Reduced sensitivity of 37_A2 to fluazinam has reduced its use, prevented management failures & driven a decline of this genotype in most countries
- Population displacement suggests 36_A2 more fit but conclusive evidence of specific fitness trait challenging to demonstrate *in vitro*
- Clonal primary inoculum is locally generated and spread. Better management of inoculum sources needed

Thanks: sponsors/contributors/collaborators

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Agrico
Belchim
BSV Network
Cheminova
CUConsulting
Emsland Group
Germicopa SAS
HZPC Holland B.V.
Neiker
PCA
Solynta
Syngenta
UPL
Vertify

ADAMA
Agrifirm
Agriphar
Bayer AG
Certis
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Eurofins
HLB
Meijer potato
Nordisk Alkali
Profytodsd
Staphyt
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