Food and Agriculture Organization of the United Nations

International Plant Protection Convention

Department for Environment Food & Rural Affairs

Revolution in plant pest diagnostics since the last century

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Agriculture Victoria Research

London, 21 – 23 September 2022

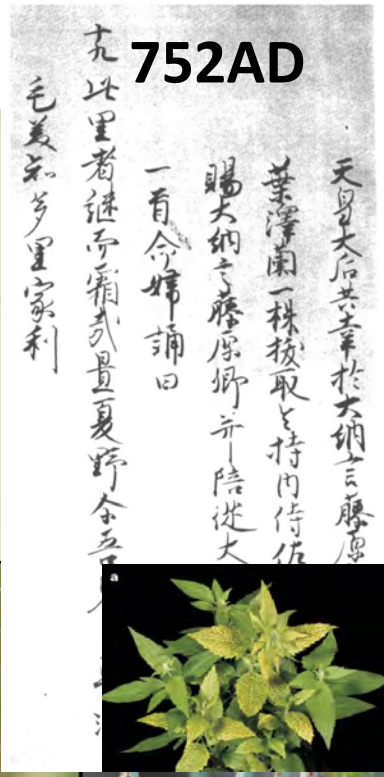
International Plant Health Conference

PROTECTING PLANTS PROTECTING LIFE

Symptomology

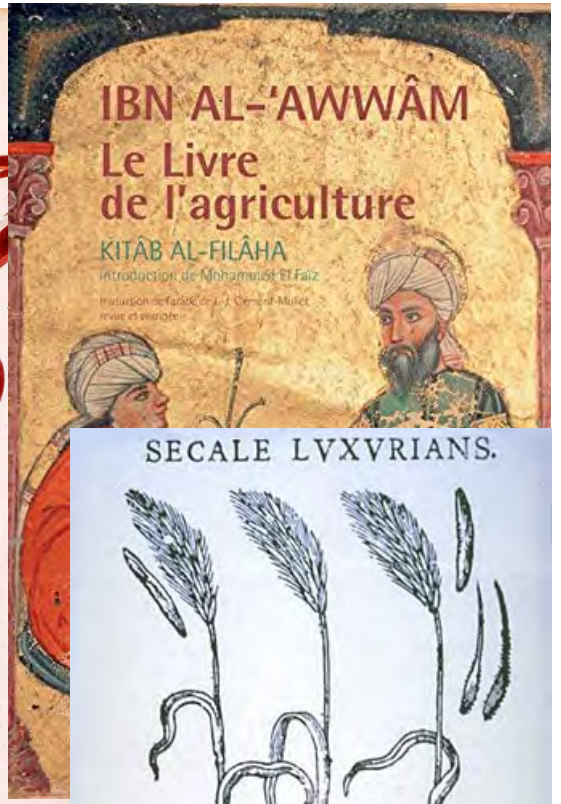
300BC

752AD



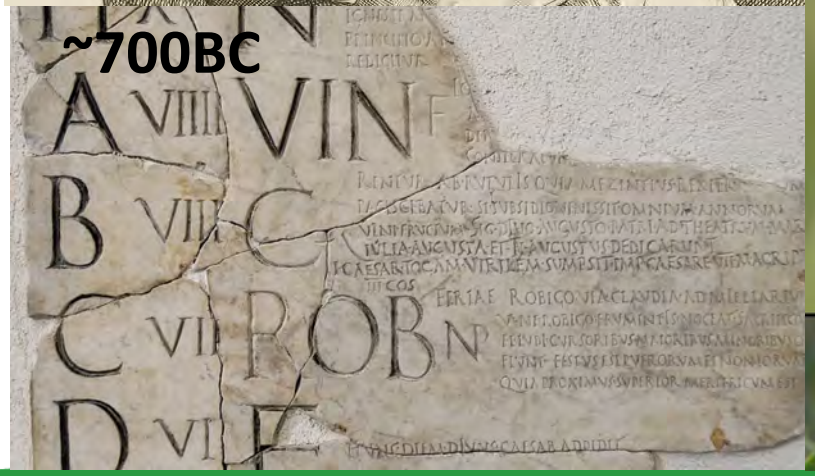
1600's

12th century



1600's

~700BC



Saunders, et al. 2003. Nature 422, 831 (2003). https://doi.org/10.1038/422831a

PROTECTING LIFE

Reproducing disease

For many years scientists thought disease causing organisms, including insects, arose spontaneously from abnormalities in the host plants

Mid-1700's onwards: transmission experiments

1755: "Brown powder" from bunt of wheat (*Tilletia tritici*) could reproduce disease (du Tillet)

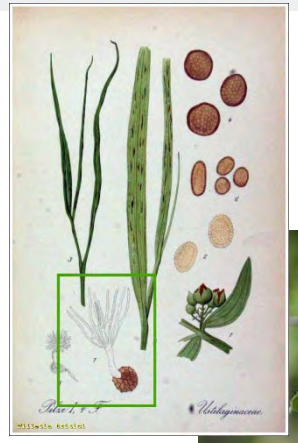
1847: Transmission of fireblight to a healthy pear tree (Gookins); Burrill proposed a bacteria 1879

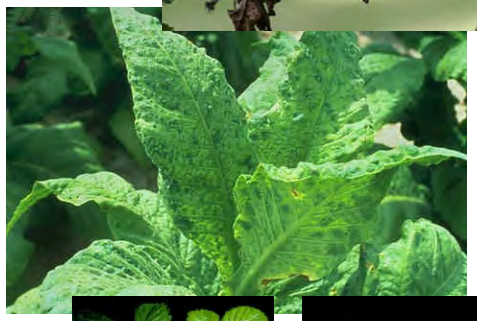
1868: Transmission a bacteria from one plant to another and caused disease (Davaine)

1886: Transmission of tobacco mosaic disease from sap (Mayer)

1890: Koch – association and cause of disease

Biological indexing

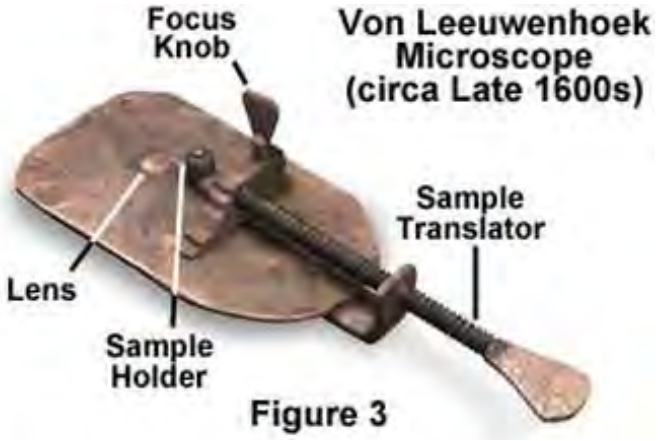


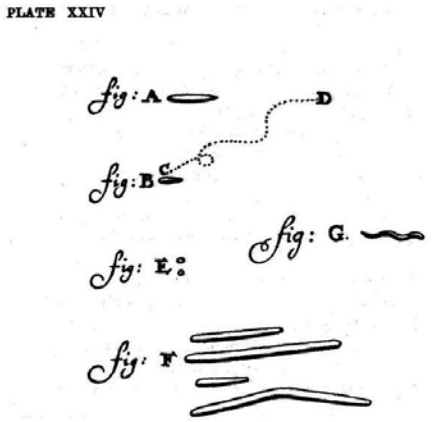


https://en.wikipedia.org/wiki/File:Apple_tree_with_fire_blight.jpg

https://www.apsnet.org/edcenter/disandpath/viral/pdlessons/Pages/TobaccoMosaic.aspx

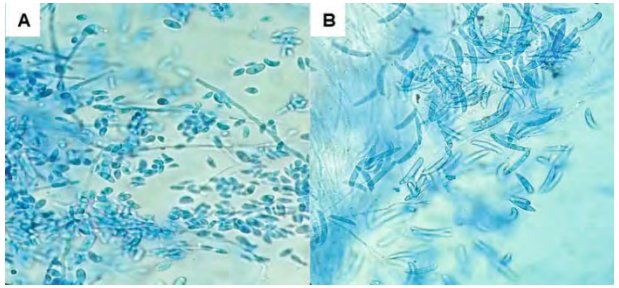
Microscopy





Joseph Jackson Lister 1830

John Leonard Riddell 1850



Fusarium oxysporum f.sp. cubense Manzo-Sánchez et al 2020

https://www.csiro.au/en/research/animals/insects/thrips-research

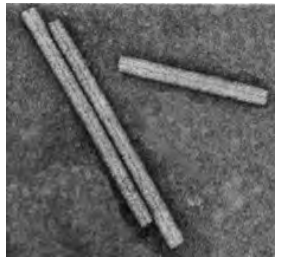
A revolution in plant virus discovery

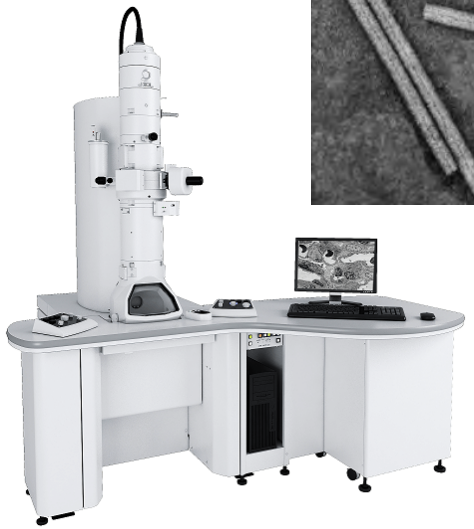
1898 - the infectious agent for tobacco mosaic disease was shown to pass through a bacterial filter (Beijernick 1898).

1935 – Crystallised TMV was still infective when used to infect plants (Stanley 1935).

1937 – TMV consisted of 5% RNA & 95% protein (Loring and Stanley 1937).

1940s and 50s – invention of the electron microscope allowed the visualisation of viruses.





Serology: revolution in high throughput pathogen detection

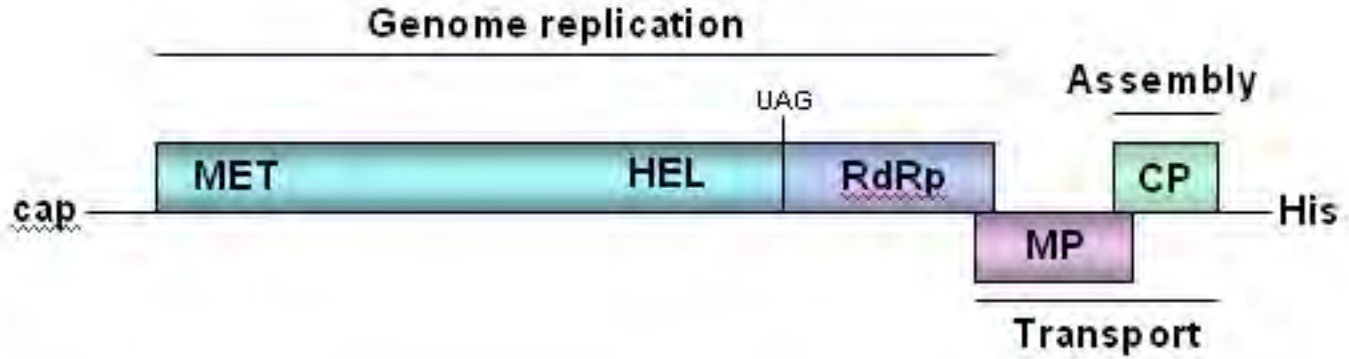
1929: Differences in antisera from TMV infected and healthy Sap (Beale)

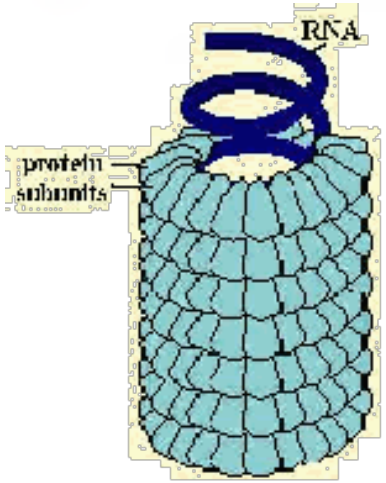
1941: First IEM observation of a virus-antibody interaction with TMV (Anderson and Stanley)

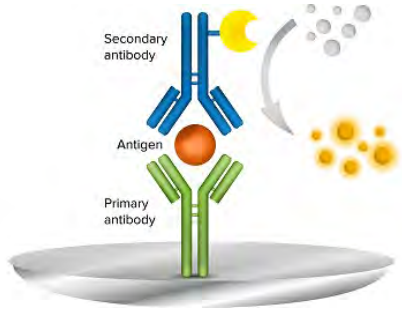
1971: ELISA was developed (Engvall and Perlman)

1976: First application of ELISA for the detection of two plant viruses (Voller, Bartlett, Bidwell, Clark, Adams)

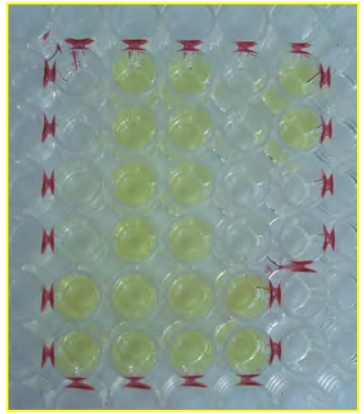
1977: Microplate ELISA method for plant viruses (Clarke and Adams)







https://www.moleculardevices.com/applications/enzyme-linked-immunosorbent-assay-elisa#gref



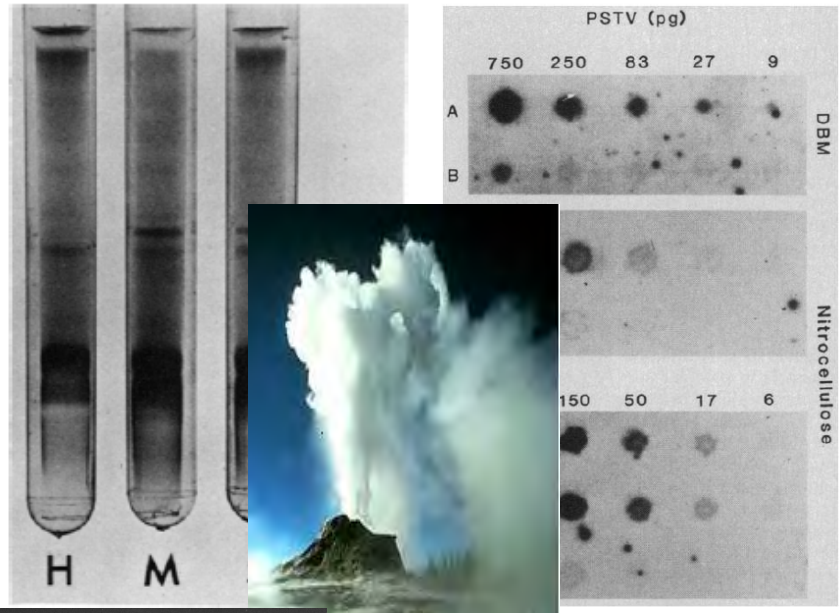
Molecular

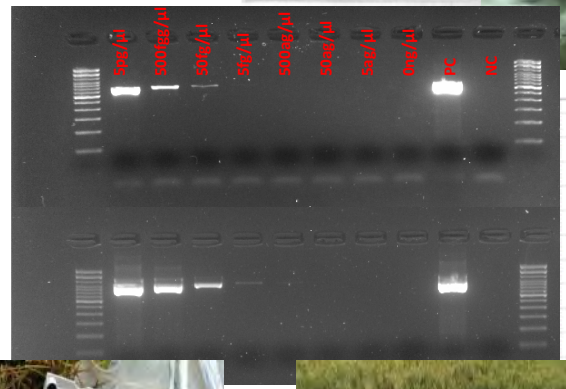
1975: Electrophoresis for detection of PSTVd (Morris and Wright)

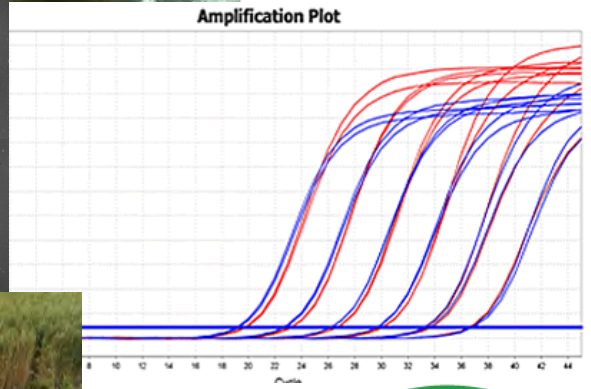
1981: Molecular hybridization for PSTVd (Owens and Deiner)

1983: Polymerase chain reaction (PCR)(Mullis et al)

2000's: Isothermal amplification for point of care testing – LAMP (2000), RPA (2006)







Sequencing

1965: tRNA *Saccharomyces cerevisiae* (Holley)

1972: DNA of a bacteriophage coat protein gene

1977: Sanger chain termination

1987: Automation ABI 370 (Hood & Hunkapiller)

1996: High throughput sequencing

Metagenomic, Meta-transcriptomic HTS

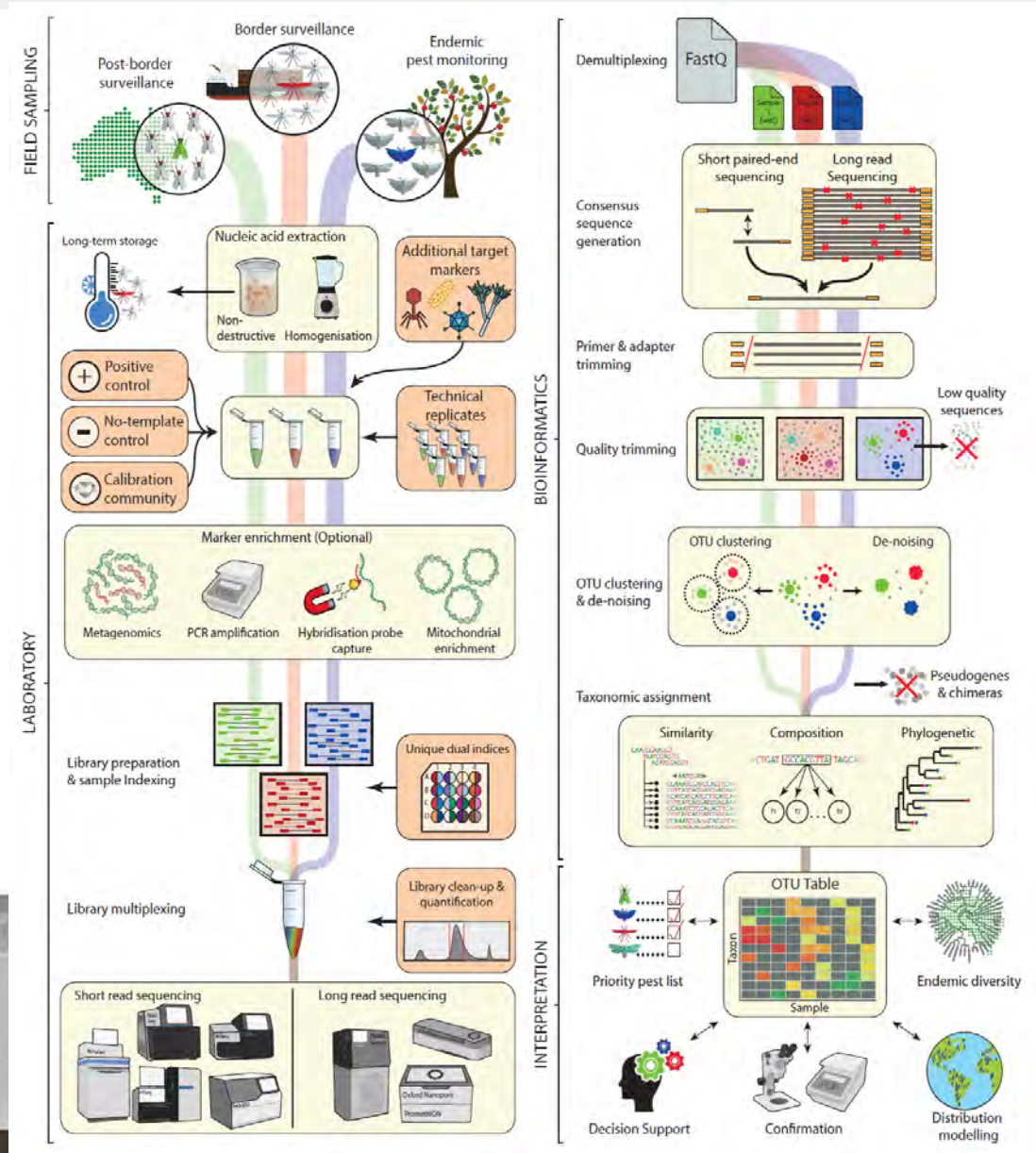
- Genome informed diagnostics

Targeted sequencing and enrichment

- Metabarcoding
- Amplicon sequencing including tiling
- Hybridization probes

Genomic epidemiology

- Surveillance
- Pathogen discovery
- Pathogen diversity
- Improved understanding of biology



Piper *et al.* 2019 *Gigascience*

Reflection

Technological advancements:

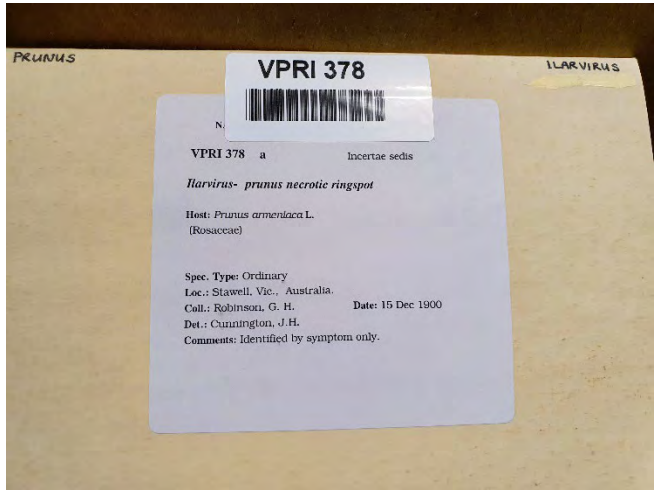
- Understanding of disease
- Disease management strategies
- Diagnostic accuracy
- Throughput

New technologies are underpinned by traditional approaches

- Trusted data

Trusted data

- Accurate diagnosis
- Decision making
  - Biosecurity, market access, etc



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Thank you

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