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Gembloux  
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## From jungle to desert : The tough trip of plant virologists

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Gembloux Agro-Bio Tech - Belgium

 @Be\_Phytopath

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## Some ecological niches of plant virologists

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## Virus discovery using HTS by plant virologists



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## Virus discovery using HTS by plant virologists



### ➤ The virus discovery party !



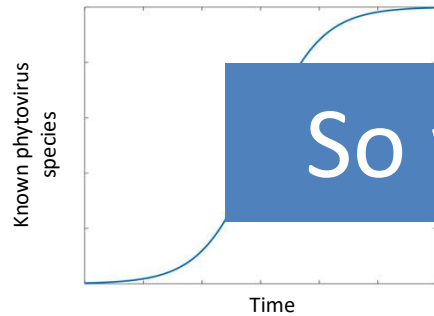
### ➤ Fruit tree viruses :

- >90 viral species discovered (until 06/2020)
- Exponential growth

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## Virus discovery using HTS by plant virologists

- The rythm will slow down
- Earth wikipedia of phytovirus



So what ??



- But when ?

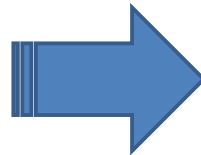
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## Downstream biological characterization



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## Downstream biological characterization



-> Impossible to evaluate biological properties of all new viruses

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Surviving kit for navigating and settling in the  
biological characterization desert

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## 1. GPS for biological characterization

### ➤ Collective characterization framework in 2017 :

frontiers  
in Microbiology

PERSPECTIVE  
published: 24 January 2017  
doi: 10.3389/fmicb.2017.00045

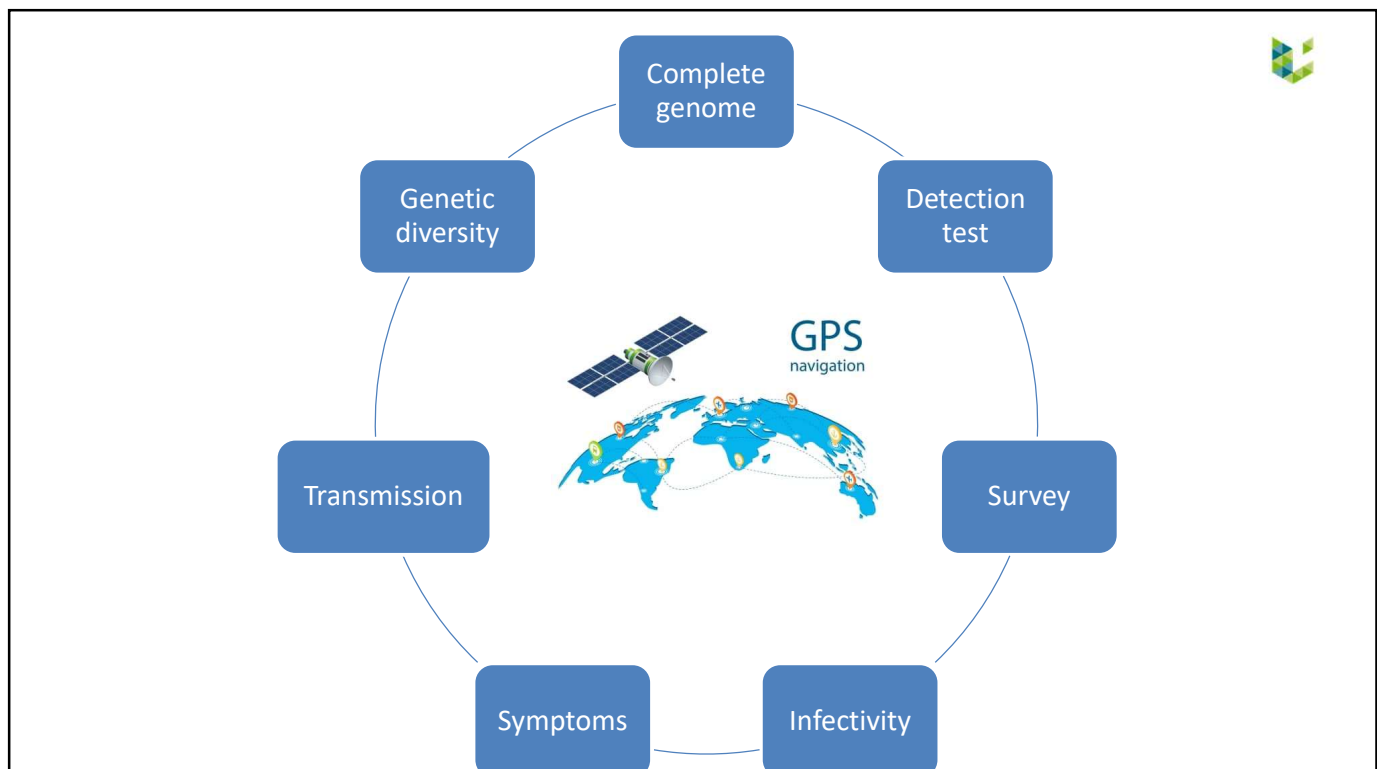


## A Framework for the Evaluation of Biosecurity, Commercial, Regulatory, and Scientific Impacts of Plant Viruses and Viroids Identified by NGS Technologies

Sebastien Massart<sup>1\*</sup>, Thierry Candresse<sup>2</sup>, José Gil<sup>3</sup>, Christophe Lacomme<sup>4</sup>, Lukas Predajna<sup>5</sup>, Maja Ravnikar<sup>6</sup>, Jean-Sébastien Reynard<sup>7</sup>, Artemis Rumbou<sup>8</sup>, Pasquale Saldarelli<sup>9</sup>, Dijana Škorić<sup>10</sup>, Eeva J. Vainio<sup>11</sup>, Jari P. T. Valkonen<sup>12</sup>, Hervé Vanderschuren<sup>13</sup>, Christina Varveri<sup>14</sup> and Thierry Wetzel<sup>15</sup>

cost  
EUROPEAN COOPERATION  
IN SCIENCE AND TECHNOLOGY

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## 2. Exploration of the desert: fruit tree & tomato

frontiers  
in Microbiology

REVIEW  
published: 19 November 2020  
doi: 10.3389/fmicb.2020.592816



frontiers  
in Microbiology

REVIEW  
published: 21 May 2021  
doi: 10.3389/fmicb.2021.671925



### Is There a “Biological Desert” With the Discovery of New Plant Viruses? A Retrospective Analysis for New Fruit Tree Viruses

Wanying Hou<sup>1,2</sup>, Shifang Li<sup>1\*</sup> and Sebastien Massart<sup>3\*</sup>

- A decade of virus discovery by HTS
- 91 putative new viral species
- How have they been characterized ?
- Reviewing 1,000 publications

### Global Advances in Tomato Virome Research: Current Status and the Impact of High-Throughput Sequencing

Mark Paul Selda Rivarez<sup>1,2</sup>, Ana Vučurović<sup>1,3</sup>, Nataša Mehle<sup>1</sup>, Maja Ravnikar<sup>1,4</sup> and Danie Kutić<sup>1\*</sup>

- A decade of virus discovery by sanger and HTS
- 45 putative new viral species
- How have they been characterized ?

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## How well the new viruses are characterized ?



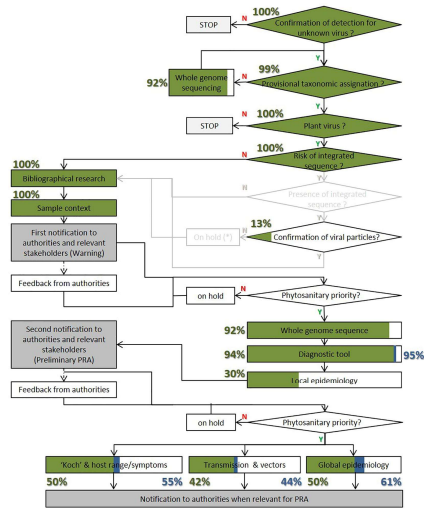
Have you explored the desert ?

[www.wooclap.com/RJLGUJ](http://www.wooclap.com/RJLGUJ)

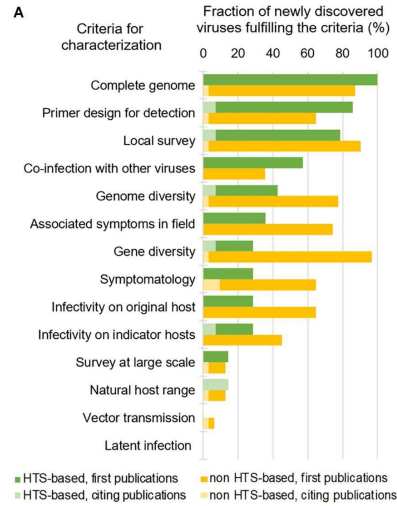


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# Levels of viral characterization



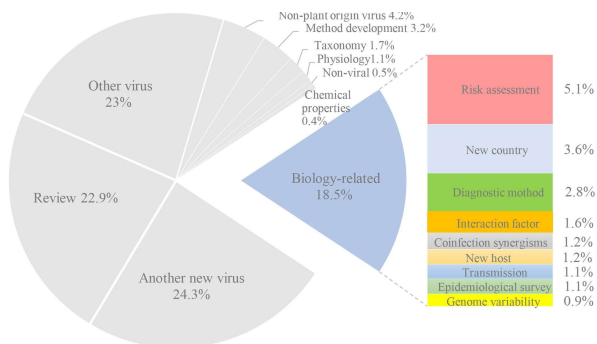
Fruit trees



Tomato

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# The citations forget biological characterization



Fruit tree viruses  
~1,000 citations reviewed

- 69% = citation in review paper or with another virus
- Only 18% of citation bring biologically-relevant information
- Once the virus is published : no one cares about biology ?

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## The Darwinian process of virus characterization

- Characterisation process = Darwinian
- Only the most threatening new viruses will be characterized and continue to live the characterization process

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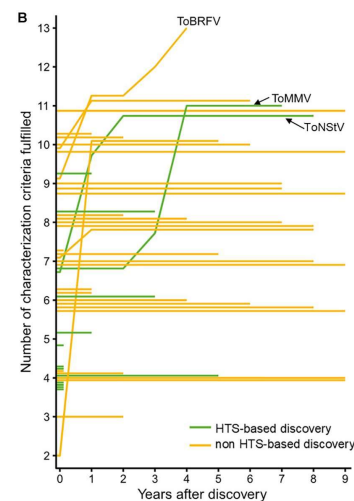
## The Darwinian process of virus characterization

- Framework = 14 steps
- « Quite » after publication
- Strong selection pressure:

45 new viruses on tomato



13 for ToBRFV in 4 years  
11 for ToMMV & ToNStV in 5 years  
(1st HTS)



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## Darwinism creates oasis in the desert

- ToBRFV as example
- In a few years, huge effort and resistant cultivar ongoing



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## Darwinism creates oasis in the desert



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## Adapting the biological framework



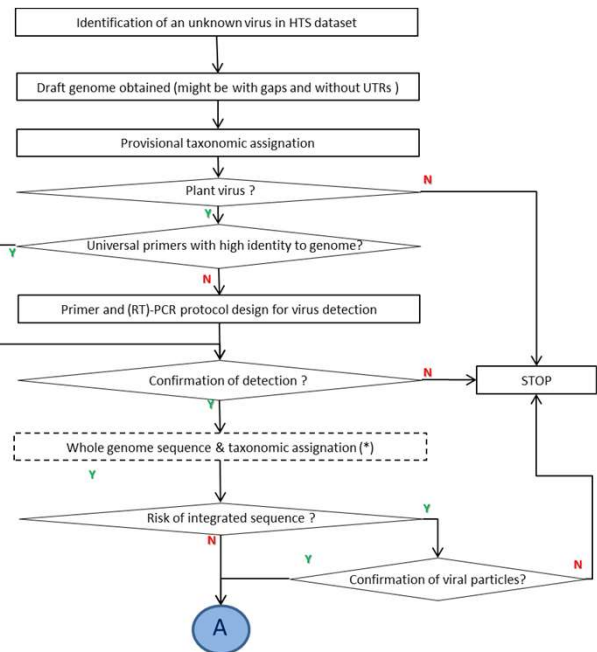
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## Adapting the biological framework

➤ Update in 2022:

Genome & taxonomy

Diagnostic test



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# Adapting the biological framework

➤ Update in 2022:

Bibliography

DECISION

Association

DECISION

Filling data gaps

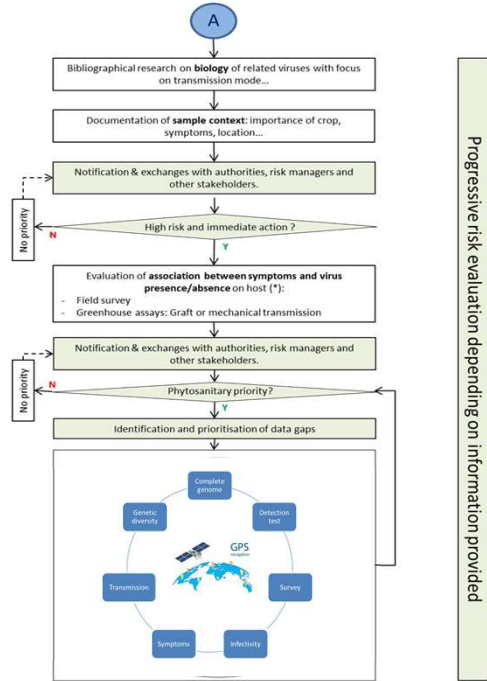


LETTER TO THE EDITOR | Full Access

Reconsidering causal association in plant virology

Adrian Fox

First published: 27 April 2020 | <https://doi.org/10.1111/ppa.13199> | Citations: 5



## GENOPREDICT :

### Genome based prediction of biological features of the newly characterized viruses

Rachid Tahzima



## Predicting biological properties ?


### ➤ An example on animal viruses:


EPIDEMIOLOGY

## Predicting reservoir hosts and arthropod vectors from evolutionary signatures in RNA virus genomes

Simon A. Babayan<sup>1,2</sup>, Richard J. Orton<sup>3</sup>, Daniel G. Streicker<sup>1,3\*</sup>

~500 known viruses:

Dinucleotide, codon pairs,  
codon and amino acids 

+  
Reservoir hosts and vectors 



Prediction accuracy:

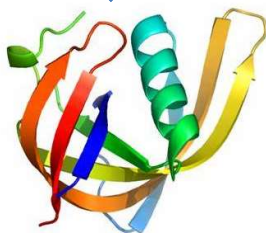
- 72 % for reservoir host
- 99 % for vector group

## Predicting biological properties ?

Genome of characterized viruses

TGAATGAGGATGAGGAAAAATGCCATACGTGCTATGCCGC  
TTCCACTTCTCTGAGAACCTGCTTCTTGATTTCGTAGAA

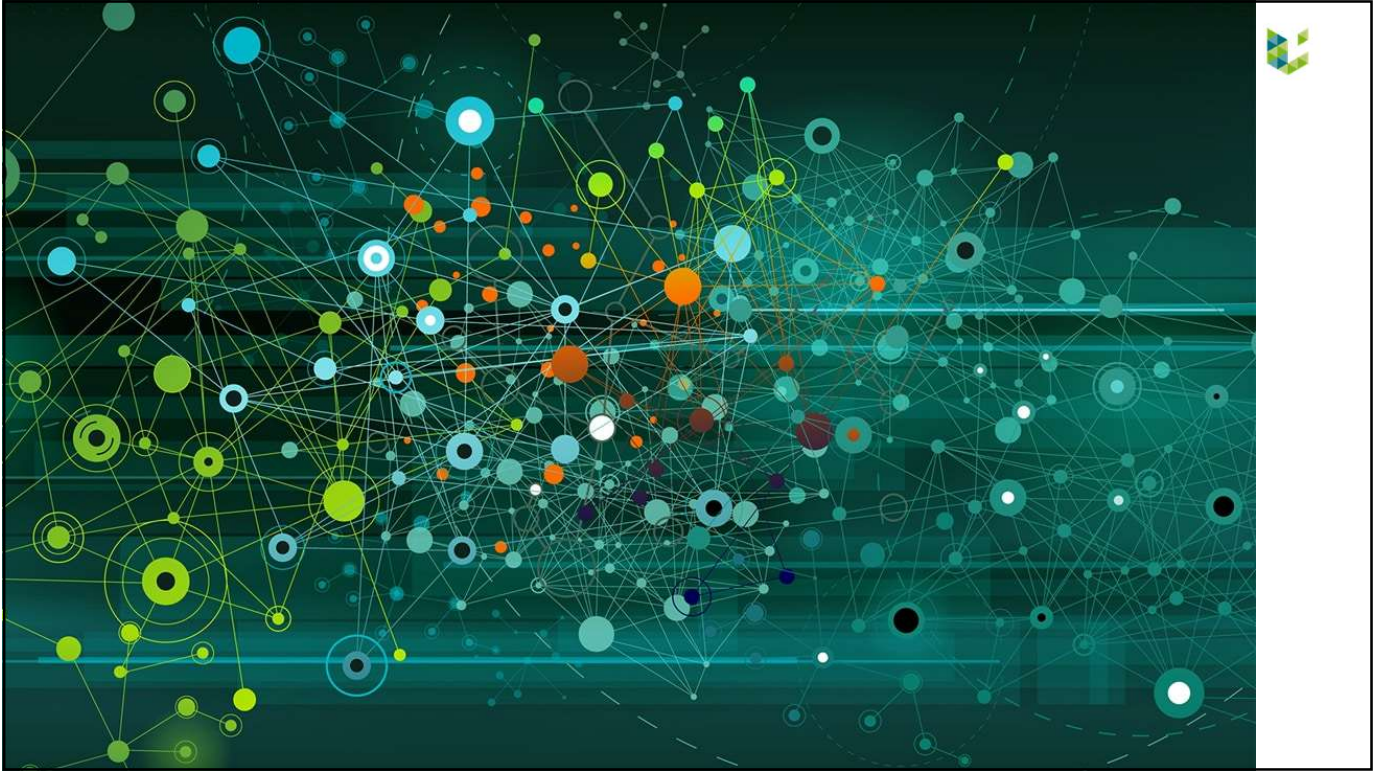
ILKYVCKTYFPASNREVYMKEFLVTR  
VNTWFCKFSRIDTFLLYKGVA



- ✓ Nucleotides bias
- ✓ Amino acids bias
- ✓ Function (GO)
- ✓ Amino acids signature (pfam...)
- ✓ 3D structure
- ✓ Intrinsic disordered region

Biological properties of  
characterized viruses

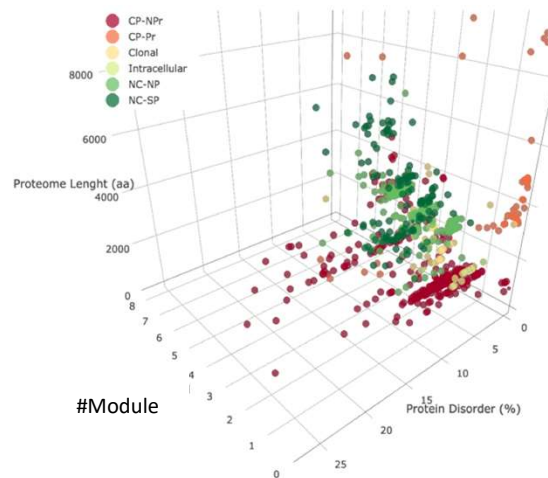




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## Predicting biological properties: transmission

### ➤ At plant virome scale

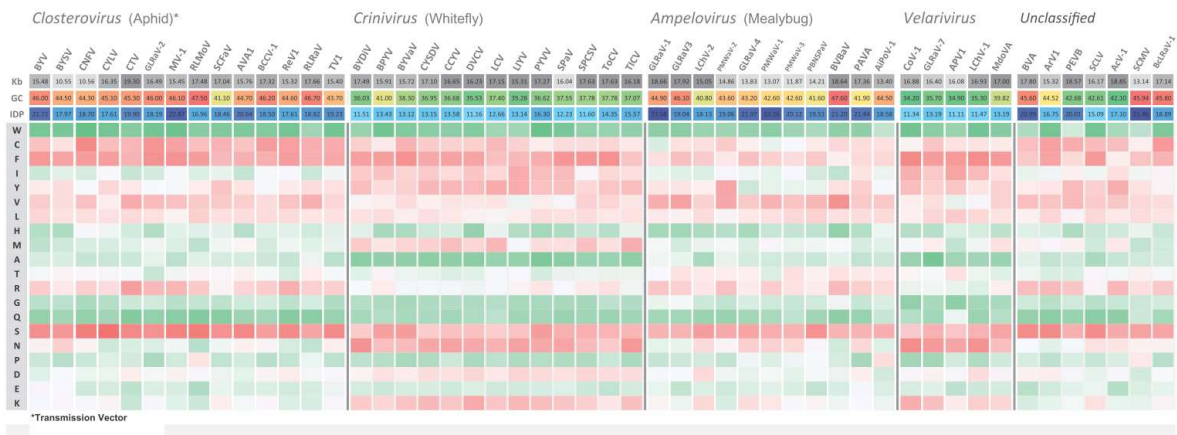


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## Predicting biological properties: vector ?

- At family scale -> hypothesis generator !



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## Conclusions on jungle, desert & oasis

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## Conclusion: plant virologists will be Tuareg



	<p><b>Biological characterization</b></p> <p>seems a desert</p>		<p><b>Characterization</b></p> <p>Framework &amp; IT</p>
	<p><b>Threat</b></p> <p>Darwinian oasis</p>		<p><b>Issues</b></p> <p>Legal Trade But closed lists !</p>

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## Thanks for the support









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**Thanks to organisers for the invitation  
Thanks for your attention**