Downy mildews affecting specialty crops, cereals & grasses

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Systematics, Diversity Studies and new reports of Downy Mildew Pathogens affecting Specialty Crops

- **Impatiens downy mildew**, *Plasmopara obducens*: population diversity
- **Rudbeckia downy mildew**, *Plasmopara halstedii*: population diversity/species diversification vs. sunflower pathogens
- ***Basidiophora delawarensis***, a new downy mildew species that infects cultivated goldenrod (*Solidago sphacelata*) in the United States
- ***Peronsopora keuwa*** sp. nov., a new downy mildew species infecting the endangered Hawaiian plant *Plantago princeps* var. *princeps*
- **Downy mildews of Monarda, Cleome, Iberis, Agastache***: Peronospora bergamoti, Hyaloperonoispora daughtreyae, and H. iberidis*: New species associated wit downy mildews affecting ornamental plants in the United States

Impatiens downy mildew (IDM)

Economic host: *Impatiens walleriana*

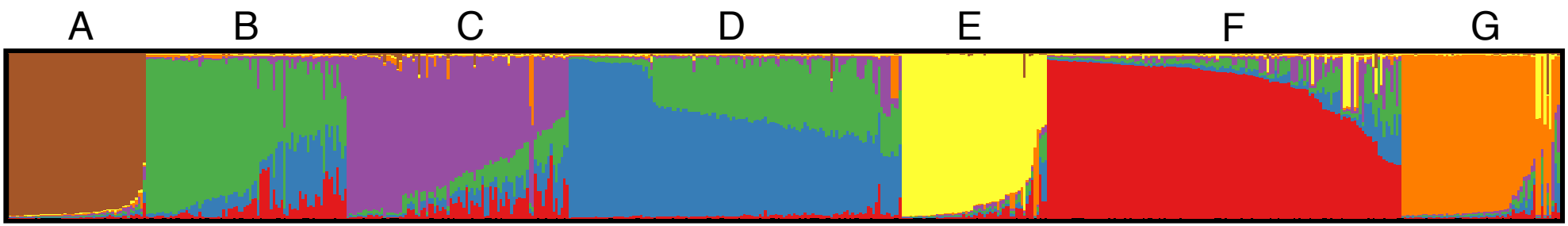
- U.S.A.: Valued at > $130 Million / year
- Reduced impatiens market by 50-60% worldwide

Pathogen: *Plasmopara obducens sensu lato*

Why is IDM suddenly killing impatiens?

- ***Impatiens:*** Genus distributed worldwide, ~ 1,000 species
- Few *Impatiens* species are native to North America
- 1960s: cultivated impatiens (*I. walleriana*) introduced to North America
- *P. obducens* described from North America since the late 1880s on native, wild relatives of cultivated impatiens, including the jewelweeds *I. capensis* and *I. pallida*
- **Is the same organism that was recorded on other *Impatiens* species in the past is responsible for the recent outbreaks on cultivated *I. walleriana?***

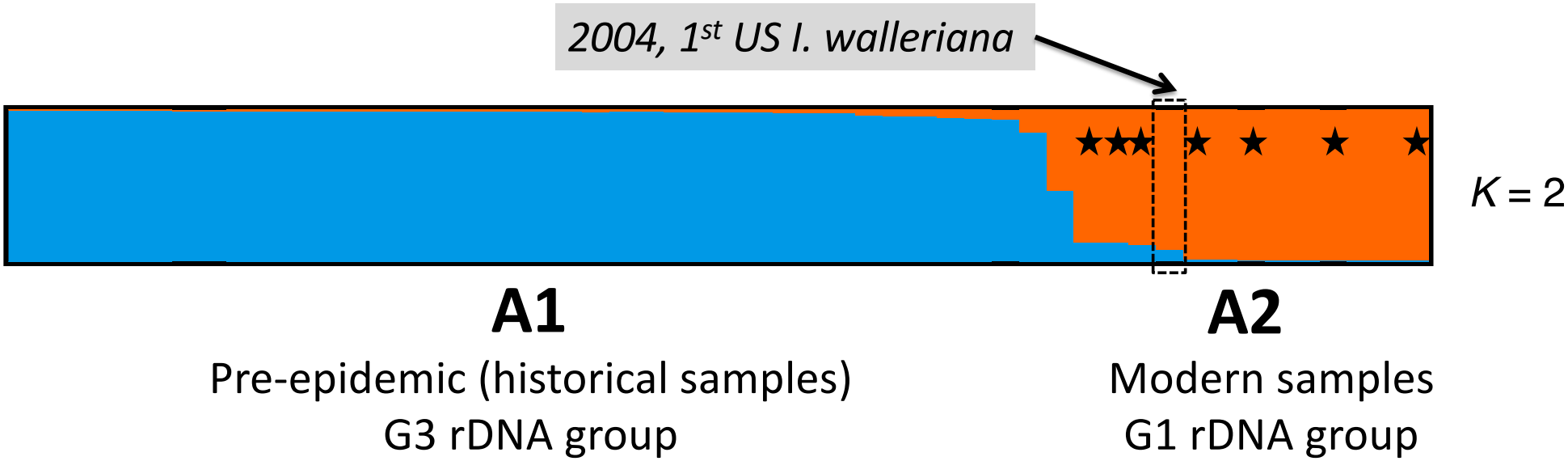
Seven populations from SSR analysis (STRUCTURE)



All pre-epidemic samples cluster in population A, along with a few modern samples

- 587 multi-locus genotypes (MLG) among the 664 samples, with the majority (82%) of MLG observed only once and the remaining observed at low frequencies
- No clustering by geographic locality
- No clustering by *Impatiens* species host
- Presence of many admixed isolates

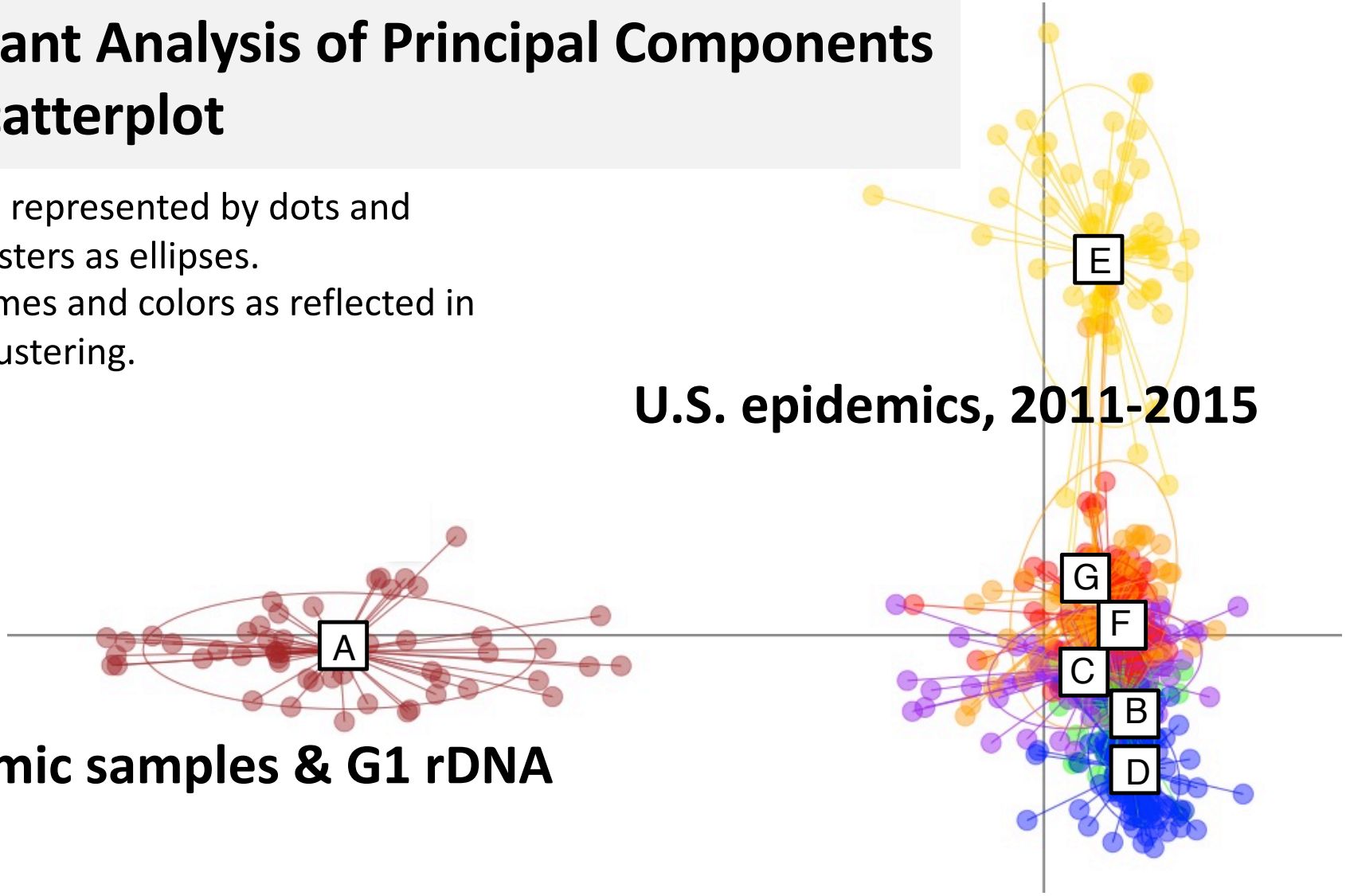
Separation between cluster A historical and modern samples



- **A1** (n = 38) herbarium specimens, 1882 to 1967 on wild relatives of the cultivated species *I. walleriana*, such as *I. aurea*, *I. biflora, I. fulva* and *I. pallida*, as well as undetermined *Impatiens* species (eastern U.S., Germany, Czech Republic)
- **A2** (n = 14). 2004 to present. Cultivated *I. walleriana*. Includes samples from Costa Rica (star), California, Pennsylvania and Tennessee

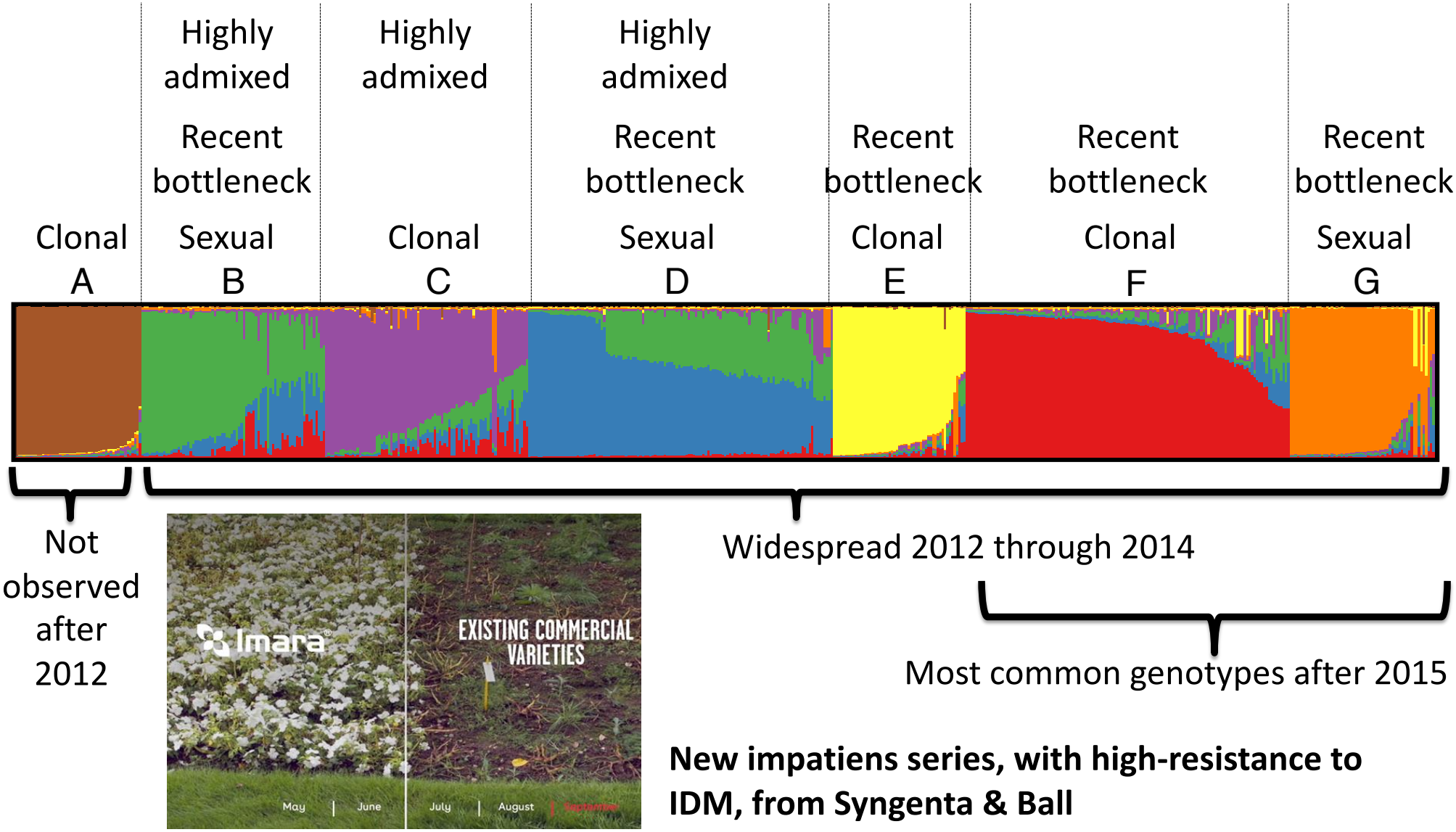
Discriminant Analysis of Principal Components (DAPC) scatterplot

Individuals are represented by dots and population clusters as ellipses.
Population names and colors as reflected in STRUCTURE clustering.



U.S. epidemics, 2011-2015

Pre-epidemic samples & G1 rDNA



New impatiens series, with high-resistance to IDM, from Syngenta & Ball

New research underway

- **Graminicolous downy mildews**
  - Deadly foreign downy mildews of cereal/grasses (some USDA-APHIS Agents): a threat to US agriculture
  - Almost nothing is known about US downy mildews on grass hosts; we are assessing genetic diversity from hundreds of herbarium specimens
- **Cucurbit downy mildew (with Lina Quesada and Kate Everts)**
- **Systematics & diversity of DM pathogens affecting Rosaseae**
  - Same species infecting rose, brambles, cherry laurel?
  - Global population structure?

Conclusions...

- Seven distinct pathogen populations associated with IDM, 1888-present
- **IDM outbreaks are not associated with the pathogen genotypes residing in the U.S. before the disease upsurge in 2011:**
  - The 2004 *I. walleriana* sample is a member of population A, in common with pre-epidemic samples on other *Impatiens* hosts, but is not a member of the major epidemic populations
  - No evidence that modern populations were present in U.S. before IDM epidemic on *I. walleriana*
  - A shift in populations occurred coincident with the onset of the main IDM epidemic on *I. walleriana* in the U.S., 2011 to present day
  - Modern populations = evidence of recent population bottlenecks (i.e. reduction in population size).
  - Modern populations are found on other *Impatiens* sp. in the U.S., including *I. balsamina* and others