Viroids
Discovery of Viroids

• The first identified: **Potato spindle tuber viroid** (PSTVd)

• PSTVd gets its name because of the oblong tubers produced from infected plants

• PSTVd can also infect tomato plants (indicator)
Discovery of Viroids

• Theodor O. Diener discovered a cell-invading plant pathogen 80 times smaller than a virus: the viroid

• Potato spindle tuber viroid (PSTVd)
Electron micrograph of a mixture of purified preparations of PSTVd RNA and viral T7 DNA. The size differences and the rod-like structure of the viroid are clearly illustrated.
Theodor O. Diener discovered a cell-invading plant pathogen 80 times smaller than a virus: the viroid

Potato spindle tuber viroid

Viroids: pure RNA. No protein.
- Active after DNase digestion
- Inactive after RNase digestion
- Active after Phenol extraction

According to accepted scientific dogma, the discovery of the viroid was not supposed to happen.
- An organism with no protein wasn't supposed to be able to replicate itself, even with a host cell's help
- Scientists believed that the minimum weight necessary for infectivity was about 1 million daltons
- An entity as small as PSTVd (130,000 daltons) wasn't supposed to be able to infect anything, even a potato.
Sequence and secondary structure of PSTVd
Citrus exocortis viroid (CEVd)

Bark sloughing caused by citrus exocortis viroid. Photo by E. Sleeth, TAES, Weslaco, 1963

Foliar distortion of citrus induced by citrus exocortis viroid.

Foliar distortion of Gynura induced by citrus exocortis viroid.
Chrysanthemum chlorotic mottle viroid (CChMVd)
Hop Stunt Viroid (HSVd) and Peach latent mosaic viroid (PLMVD)

Plum Dapple by HSVd

Peach infected with PLMVD
Viroids

- Small RNA pathogens infecting plants (240 – 400 nt)
- 200–10,000 copies per cell
- Single-stranded and circular genomes
- Not encapsidated
- No coding regions
- Formed by Quasi-species
- Symptoms that are as varied as those caused by plant viruses
  - ✓ stunting  ✓ epinasty  ✓ chlorosis
  - ✓ localized necrosis  ✓ death

- Despite their small sizes, and therefore extremely limited genetic information, viroids are replicated autonomously (requiring no helper virus) in susceptible cells
- Replicated by a host RNA-dependent RNA polymerase
  - ➢ host DNA-dependent RNA polymerase that can act also on RNA templates
Viroids

• Infect many hosts (ex. PLMVd):
  ➢ Peach ➢ Plum
  ➢ Cherry ➢ Nectarin
  ➢ Pear ➢ Almonds
  ➢ Apple ➢ Apricots

• Transmission:
  ➢ By mechanical breaks
    ✔ Tools, breaks, insects
  ➢ Biologiquement
    ✔ Germs, co-infection

• May be latent for many years
**Viroid localization**

**Avsunviroidae**
- avocado sunblotch (ASBVd)
- peach latent mosaic (PLMvd)
- chrysanthemum chlorotic mottle (CChMVd)
- eggplant latent viroid (ELVd)

**Pospiviroidae**
- potato spindle tuber (PSTVd)
- citrus exocortis (CEVd)
- columnnea latent (CLVd)
- chrysanthemum stunt (CSVd)
- iresine (IRVd)
- mexican papita (MPVd)
- citrus viroid-IV (CVd-IV)
- hop latent viroid (HLVd)
- hop stunt (HSVd)
- coleus blumei-1 (CbVd-1)
- coleus blumei-2 (CbVd-2)
- coleus blumei-3 (CbVd-3)
- coconut cadang-cadang (CCCVd)
- grapevine yellow speckle-1 (GYSVd-1)
- grapevine yellow speckle-2 (GYSVd-2)
- coconut tinangaja (CTiVd)
- australian grapevine (AGVd)
- apple dimple fruit (ADFVd)
- apple scar skin (ASSVd)
- citrus bent leaf (CBLVd)
- citrus viroid-III (CVd-III)
- citrus viroid-OS (CVd-OS)
- grapevine 1B (G1BVd)
- pear blister canker (PBCVd)
- tomato apical stunt (TASVd)
- tomato planta macho (TPMVd)
- tomato chlorotic dwarf (TCDVd)
<table>
<thead>
<tr>
<th>Species Name</th>
<th>Abbreviation</th>
<th>Number of sequences</th>
<th>Size (in nucleotides)</th>
<th>Secondary Structure (Connect files)</th>
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<td>Peach latent mosaic viroid</td>
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<td>325 - 351</td>
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Viroid conformations

**Pospiviroidae (PSTVd)**

**Avsunviroidae (PLMVd)**
Subgroups of Pospiviroids are based on the sequences of the central conserved region

**PSTV**

Subgroup

```
5' --> A G AGGGAU CC CCGG GGAAACCU --> 3'
  . . . .
3' --> AACAAAO GG GGCC CAUCA --> 5'
  OT C U G G
```

**ASSV**

Subgroup

```
5' --> UC GUC G UCGAC G A A GG --> 3'
  . . .
3' --> CAG C G AGCUG A C G CC --> 5'
  U A U C
```

**CbV**

Subgroup

```
5' --> CCU G GCAG GCUC GC A --> 3'
  . . . .
3' --> GGA CGUU A GCGA C G C --> 5'
  A A A
```
Rolling circle replication mechanisms

Symmetrical
(Avsunviroidae)

Asymmetrical
(Pospiviroidae)
Replication

Pospiviroids:

• Nuclear RNA polymerase II
  ✓ Nuclear localization
  ✓ α-amanitin sensibility

• RNase and Ligase activities unknown