Phytoplasmas

Pl. Path. 502

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What are Phytoplasmas?

- Phytoplasmas have diverged from gram-positive eubacteria, and belong to the Genus Phytoplasma within the Class Mollicutes.

- Mycoplasmas dramatically differ phenotypically from other bacteria by their minute size (0.3 - 0.5 and lack of cell wall. The lack of cell wall was used to separate mycoplasmas from other bacteria in a class named Mollicutes. Due to degenerative or reductive evolution, accompanied by significant losses of genomic sequences, the genomes of mollicutes have shrunk and are relatively small compared to other bacteria, ranging from 580 kb. to 2,200 kb.
Phytoplasma

• Phytoplasma are wall-less prokaryotic organisms

• Seen with electron microscope in the phloem of infected plant

• Unable to grow on culture media

• Pleomorphic shaped and spiral
Phytoplasma

- Most phytoplasma transmitted from plant to plant by
  - leafhoppers,
  - but some are transmitted by Psyllids and planthoppers

- Caused Yellowing, Big bud, Stunting, Witchbroom

- Sensitive to antibiotics, especially Tetracycline group
Mycoplasma (Phytoplsmas): Doi et al. (1970) are submicroscopic, measuring 150-300 nm in diameter having ribosomes and DNA strands enclosed by a bilayer membrane but not the cell wall, replicate by binary fission, can be cultured artificially *in vitro* on specific medium and are sensitive to certain antibiotics (tetracycline not to penicillin).

E.g. Little leaf of brinjal, Peach yellow Spiroplasm citri (Fudt Allh et al. 1571) Citrus stubbesh.
Classification

■ Class: Mollicutes
■ Order: Mycoplasmatales.
■ Three families, each with one genus:
  ■ Mycoplasmataceae,
    ■ genus Mycoplasma,
  ■ Acholeplasmataceae,
    ■ genus Acholeplasma,
  ■ Spiroplasmataceae
    ■ genus Spiroplasma.
■ Genetically, phytoplasmas are more related to Acholeplasma than to Mycoplasma.
Fig. Phylogenetic relationships of 5 phylogenetic groups within the Class Mollicutes.
FIGURE 12-45  Aster yellows phytoplasma. (A) Typical large mycoplasmalike bodies bound by a unit membrane and containing strands resembling DNA. The smaller particles contain ribosomes. (B) Phytoplasmas in cytoplasm of infected phloem parenchyma cell. (C, D) Several polymorphic phytoplasmas (C) and some apparently undergoing binary fission or budding (C, D). (E) Invagination of some phytoplasmas by others, indicating the extreme pliability of the organisms. (Photos courtesy J. F. Worley.) Magnification = 15,000×.
Spiroplasmas

- Spiroplasmas are helical mollicutes.
- Spiroplasmas are known to cause the stubborn disease in citrus plants and the brittle root disease in horseradish
- *Spiroplasma citri*,
  - **stunt disease in corn plants, and periwinkle.**
- *Spiroplasma citri* has also been found in many other dicots, such as crucifers, lettuce, and peach
- Both *S. citri* and the corn stunt spiroplasma also *infect* their respective leafhopper vectors.
**Spiroplasma citri.**

(A) **Typical helical morphology of spiroplasma.**

(B) **Active spiroplasmas from liquid culture observed by dark-field microscopy.**

(C) **Colonies of corn stunt spiroplasma on agar plates 14 days after inoculation (scale bar: 50 mm).**

(D) **Replicative form of Spiroplasma citri isolated from stubborn-infected citrus.**

(E) **Spiroplasma citri obtained from its leafhopper vector Circulifer tenellus and grown in broth culture. Note presence of bleb.**

(F) **Spiroplasma citri in sieve plate in midvein of a sweet orange leaf.**
Phytoplasmas cause severe symptoms such as, stunting, phyllody, witches broom, yellowing, yield losses in over 300 economically important plant species worldwide.

These organisms are not transmitted via plant seeds, but may be transovarially transmitted to next-generation leafhoppers.

The molecular and genetic mechanisms underlying the diverse interactions between plant pathogenic phytoplasmas and their plant or insect hosts remain unknown.
Transmission

- Transmission of phytoplasmas to plants occurs when leafhoppers feed from plant phloem.
  - introduced into plant phloem with insect saliva.
- In plants, phytoplasmas remain restricted to the phloem tissue where they systemically spread throughout the plant.
Fig. A. Healthy China aster, and B. China aster infected with the Aster Yellows isolate Witches' Broom (AY-WB) phytoplasma.
Fig. 7. Aster Yellows isolate Witches' Broom (AY-WB) phytoplasmas (arrows) in two adjacent sieve elements (se1 and se2) of an infected aster leaf (Hogenhout and Ammar, 2006); note the rudimentary nucleus (n) in a maturing sieve element (se1), next to a companion cell (cc). Other abbreviations used in figure: pl, plastid; spl, sieve plate. Scale bar = 1 um.
Field infected citrus plant with stubborn disease, *Spiroplasma citri*
Citrus stubborn disease caused by *Spiroplasma citri*
Tomato big-bud disease caused by Phytoplasma
Tomato flowers showed Big-Bud symptoms
FIGURE 12-58  (A) Corn stunt disease in corn. Leaves show chlorotic streaks, plant is stunted, proliferation begins at nodes, and tassel is sterile. (B) Portions of corn stunt spiroplasmas as seen in a section of phloem tissue from a corn stunt-infected plant. (Photos courtesy R. E. Davis; photo B from Phytopathology (1973) 63, 403–408.) Magnification = 6000×.
**Figure 12-49** Corn stunt spiroplasmas isolated from infected corn plants and grown on nutrient media. (A) Electron micrograph of spiroplasma showing typical helical morphology (scale bar: 0.5 µm). (B) Living spiroplasmas from liquid cultures observed by dark-field microscopy. (C) Colonies of corn stunt spiroplasmas on agar plates 14 days after inoculation (scale bar: 50 µm). (Photos courtesy T. A. Chen and Liao, *Science* 188, 1015–1017. Copyright 1975 by the American Association for the Advancement of Science.)
Sugarcane grassy shoot
Witches'-broom disease of Longan
Sesame Phyllody