

The Occurrence and Control of Fungal and Bacterial Orchid Diseases

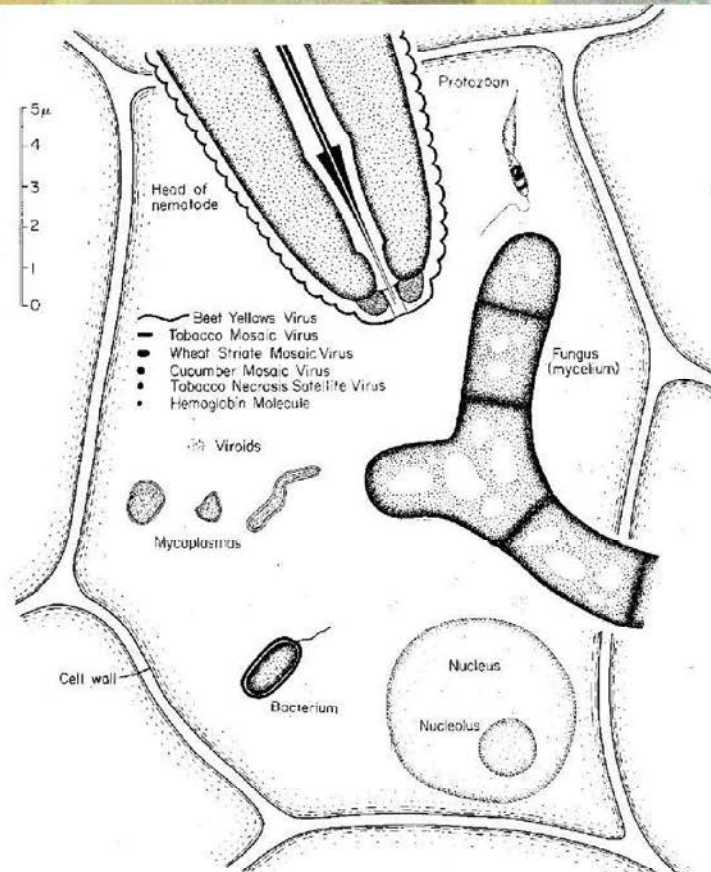
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Mar. 6, 2008



Major Plant Patogens

- **Viruses** – nucleoproteins composed of **RNA or DNA** surrounded by **coat proteins**, able to cause diseases, multiplication only in living cells, too **small** to be seen individually with a light microscope.
- **Fungi** - small, generally microscopic, eucaryotic (organelles bound by membranes, with 80S and 70S ribosomes), usually **filamentous, branched, spore-bearing, without chlorophyll**, with cell wall containing chitin and glucan as the skeletal components.
- **Bacteria** - procaryotic, generally **single-celled** surrounded by cell walls, microscopic, genetic material (DNA) not bound by a membrane, cytoplasm containing DNA and small (70S) ribosomes, without an organized nucleus.






Schematic diagram of the shapes and size of certain plant pathogens in relation to a plant cell (Agrios, G. N., 1997)

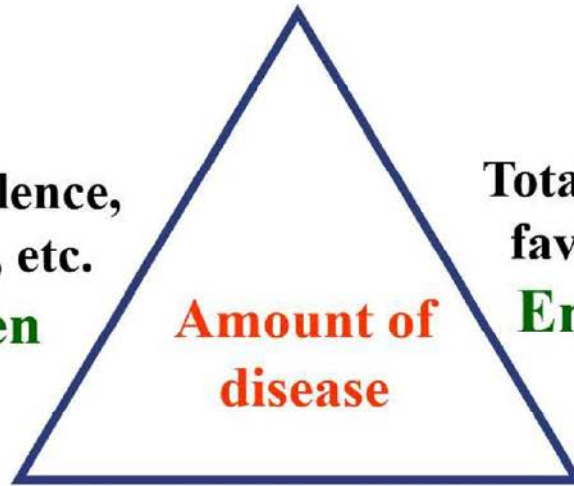
(For education only)





Total of virulence,
abundance, etc.
Pathogen

Total of conditions
favoring disease
Environment



**Amount of
disease**

Total of conditions
favoring susceptibility
Host

The Disease Triangle



Characristics of Bacterial Plant Diseases

■ Favorable conditions for infection

Moist and warm (25~30 ° C), existence of free water, natural opening or wound in plants.

■ Control of bacterial plant diseases

◆ Usually difficult to control, a combination of control measures required.

◆ Comparatively effective chemicals

– Antibiotics: streptomycin, tetracycline, streptomycin+tetracycline, **oxolinic acid**, thiophanate methyl+streptomycin, etc.

– Copper compounds: cupric hydroxide, kasugamycin+copper oxychloride, etc..

– Systemic acquired resistance inducers : teclotalam, probenazole.

* **Timely application** for best efficacy; Limited effect.

→ **Drug-resistant strains were selected and become predominant by frequent use of limited chemicals**



Soft Rot (軟腐病) of Orchids

Pathogen : *Pectobacterium chrysanthemi*

(Synonym : *Erwinia chrysanthemi*)

Taxonomic Position of *Pectobacterium*

- Phylum: Proteobacteria
- Class: γ -proteobacteria
- Order: Enterobacteriales
- Family: Enterobacteriaceae
- Genus: *Pectobacterium*



- ◆ Previous name — *Erwinia chrysanthemi*
- ◆ Nominated as *Pectobacterium chrysanthemi* by Hauben *et. al.* in 1998.



Characteristics of *P. chrysanthemi*

- Motile, Gram-negative, non-sporing, straight rod with rounded ends, and occurs singly or in pairs; it varies from 0.8-3.2 x 0.5-0.8 μm (average 1.8 x 0.6 μm). There are usually **8-11 peritrichous flagellae**. On NA, colonies are **milk white** with **irregular margins**. When watched from certain angles, the colonies show wrinkled glisten.
- World-wide distribution. Diseases have most often been reported on bananas, carnations, chrysanthemums, *Dahlia*, *Dieffenbachia* spp., *Euphorbia pulcherrima*, *Kalanchoe blossfeldiana*, maize, *Philodendron* spp., potatoes, *Saintpaulia ionantha*, *Syngonium podophyllum*. It also attacks allium, *Brassica chinensis*, *Capsicum* spp., carrots, celery, chicory, taro, alfalfa, onions, pineapples, radishes, rice, sugarcane, sorghum, sweet potatoes, tobacco, tomatoes, tulips and glasshouse ornamentals such as *Aechmea fasciata*, *Aglaonema pictum*, *Begonia intermedia* cv. Bertinii, *Cyclamen* sp., *Dracaena marginata*, *Opuntia* sp., *Parthenium argentatum*, *Pelargonium capitatum*, ***Phalaenopsis* spp.**, *Cymbidium* spp., *Oncidium* spp., *Cattleya* spp., and other **succulent plants**.





Soft rot of allium



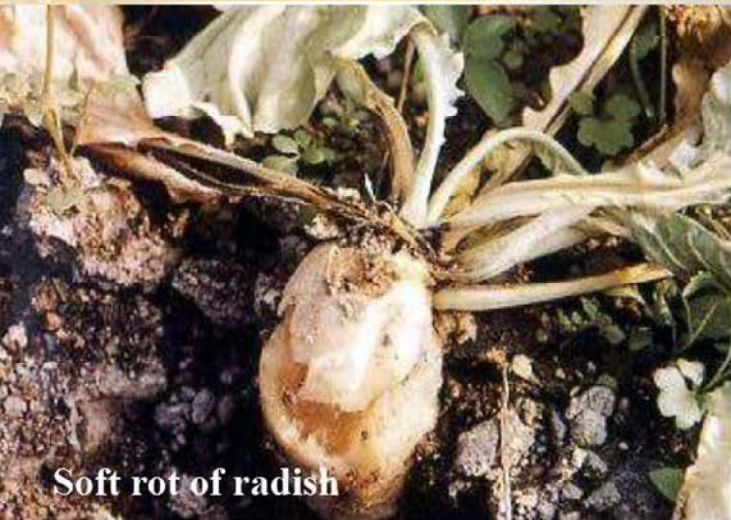
Soft rot of celery



Soft rot of celery



Soft rot of carrot



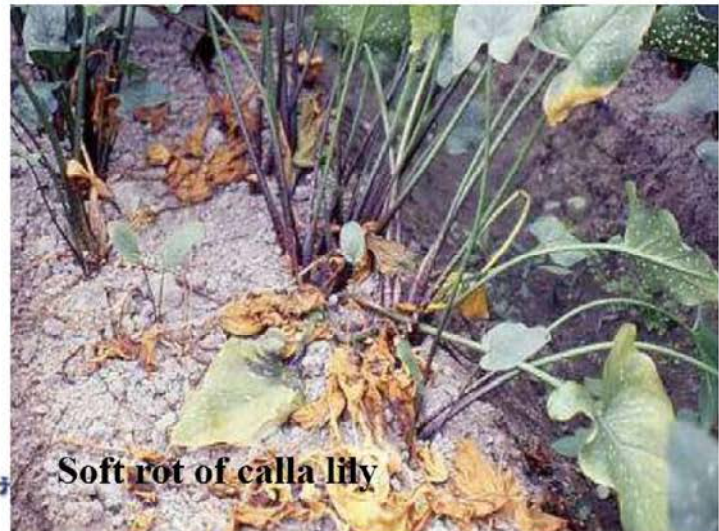
Soft rot of radish



Soft rot of potato



Soft rot of taro



Soft rot of calla lily



**Middle stage of soft rot
in oncidium orchids**



**Late stage of soft rot
in oncidium orchids**



2007/08/15



Soft rot of *Cymbidium* sp. (虎頭蘭)



Soft rot of cattleya



Oncidium



Oncidium



Soft rot is one of the most destructive diseases in phalaenopsis orchids



Cymbidium sp. (建蘭)

Young leaf infected with *P. chrysanthemi*



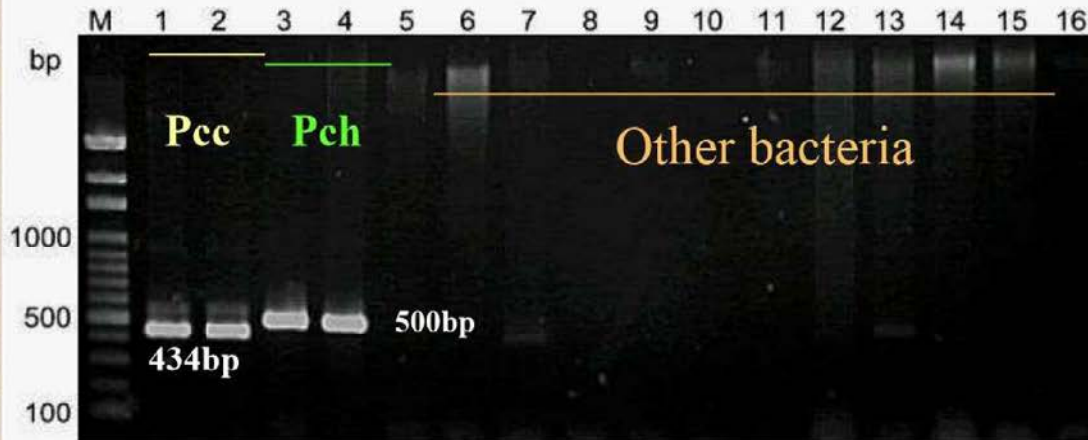
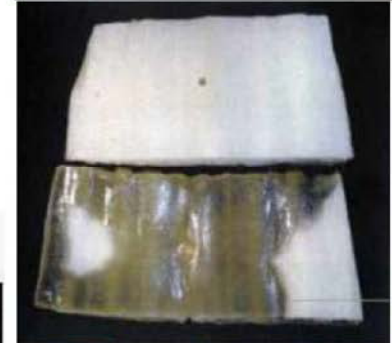
Biology of *P. chrysanthemi*

- It's a soft rot pathogen degrading succulent fleshy plant organs such as roots, tubers, stem cuttings and thick leaves; also a vascular wilt pathogen, colonizing the xylem and becoming systemic within the plant.
- Able to survive on healthy phalaenopsis leaves for about 45 days, in detached diseased phalaenopsis tissue for about 10 days, on leaves of some weeds for about 25 days, on sphagnum moss planted with phalaenopsis for about 60 days.
- High humidity and **free water** favor spread and penetration of the bacteria; disease development dependent on high temperatures, generally **25-30°C**.
- Ubiquitous; host specialization not definitely been proved.



Diagnosis of Bacterial Soft Rot

- **Bacterial streaming** from soft-rotted tissue observed with light microscope (100~200X).
- Soft rot of Chinese cabbage or potato tissues resulting from close contact with fresh soft-rotted tissue of orchids under warm (25~30 °C) and humid condition in 2~3 days.
- PCR analysis using smashed fresh soft-rotted tissue as template and certain DNA sequences as primers.





Control of Soft Rot of Orchids

- Strict attention to horticultural practices, sanitation, and plant hygiene in the nursery or glasshouse.
 - ◆ Avoid dense arrangement of orchid plants; remove weeds and other plants
 - ◆ Remove and destroy all leaves or entire plants showing infection
 - ◆ Avoid overhead watering as it spreads the bacteria
- Timely application of proper bactericides
 - ◆ Antibiotics: streptomycin, tetracycline, streptomycin+tetracycline, **oxolinic acid**, thiophanate methyl+streptomycin, etc.
 - ◆ Copper compounds: cupric hydroxide, kasugamycin+copper oxychloride, etc..
 - ✳ **It's advised that each chemical should be subjected to small-scale tests for phytotoxicity before large-scale application.**



Disease Severity of Soft Rot in Phalaenopsis after Application of Different Chemicals (1998)



Treatment	Dilution	Disease severity (%) ^a		
		9 days	12 days	16 days
30.3% Tetracycline SP	2,000×	0.8 ^b	0.8 ^b	1.7 ^b
10% streptomycin+ tetracycline WP	1,000×	1 ^b	2.9 ^b	3.3 ^b
68.8% thiophanate methyl+streptomycin WP	1,000×	1.7 ^b	3.5 ^b	5.0 ^b
20% Oxolinic acid WP	1,000×	5 ^b	5.2 ^b	6.7 ^b
81.3% kasugamycin+copper oxychloride WP	1,000×	7.9 ^b	9.6 ^b	11.7 ^b
Control	—	26.9 ^a	33.8 ^a	41.7 ^a

^a Pch suspension mixed with carborundum was sprayed onto orchid plants followed by chemical application after 24 hours. Data are the average disease severities of 4 replicates, 20 plants per replicate, investigated certain days after chemical application. Data in the same column followed by the same letter are not significantly different according to DMRT (P=0.01).



蝴蝶蘭軟腐病防治試驗(1998)



處理藥劑	倍數	罹病度(%) ^a		
		9 天後	12 天後	16 天後
30.3%四環黴素 SP	2,000×	0.8 ^b	0.8 ^b	1.7 ^b
10%鏈四環黴素 WP	1,000×	1 ^b	2.9 ^b	3.3 ^b
68.8%多保鏈黴素 WP	1,000×	1.7 ^b	3.5 ^b	5.0 ^b
20%歐索林酸 WP	1,000×	5 ^b	5.2 ^b	6.7 ^b
81.3%嘉賜銅 WP	1,000×	7.9 ^b	9.6 ^b	11.7 ^b
不處理對照	—	26.9 ^a	33.8 ^a	41.7 ^a

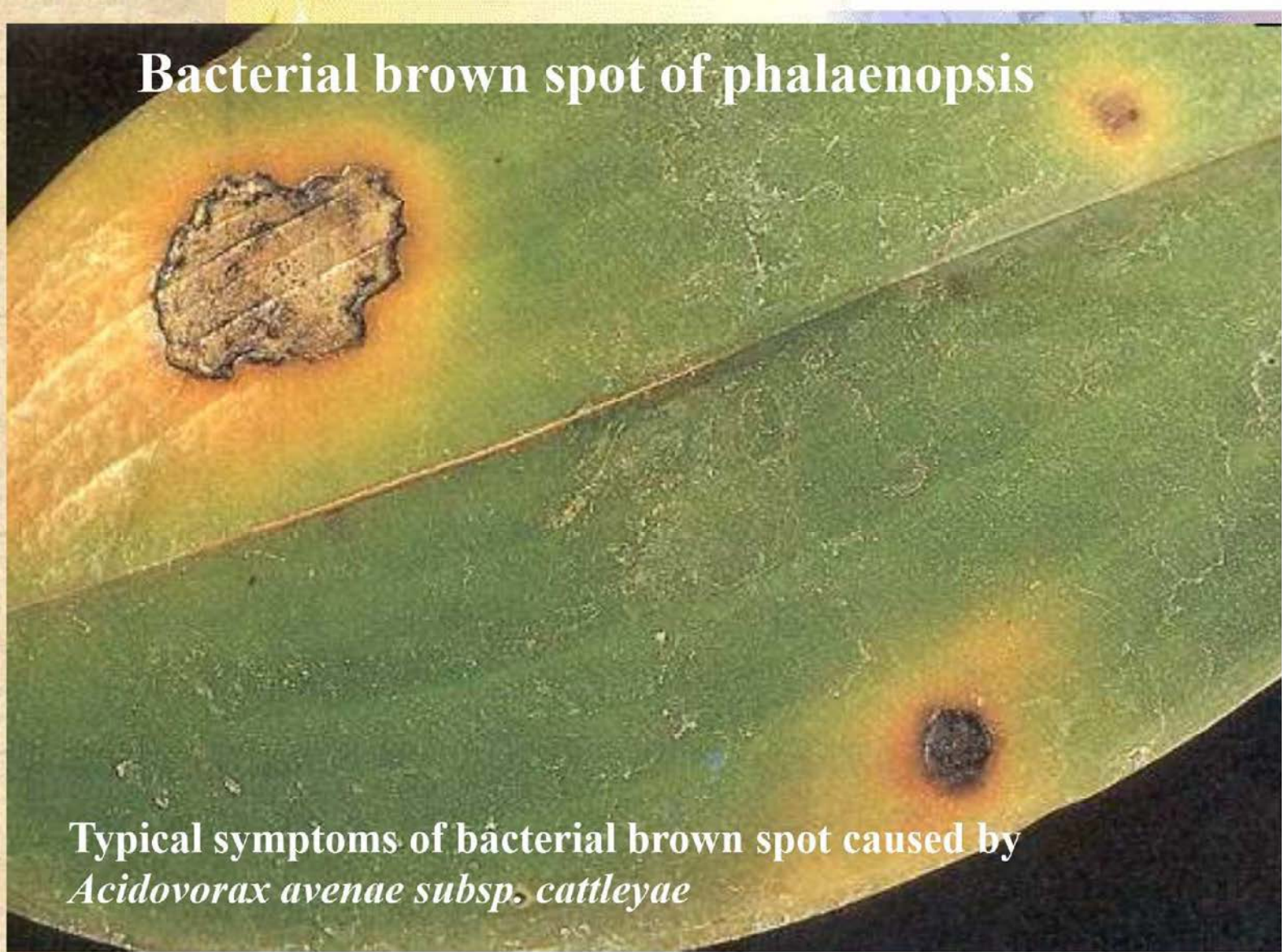
^a 組織先噴藥，24 小時後再噴霧接種軟腐病菌每處理 20 株，重複 4 次，數值為 4 重複之平均值，每欄字母相同者表示經鄧肯氏多重變域分析差異不顯著(P=0.01).



A large, well-managed glasshouse filled with rows of potted phalaenopsis orchids. The plants are lush green and arranged in neat rows. The glasshouse has a complex metal frame and a glass roof. A large, white, cylindrical object, possibly a ventilation or lighting fixture, hangs from the ceiling. The background shows a brown wall and a person working in the distance.

**A well managed glasshouse for the cultivation of
phalaenopsis for export to the USA**

Bacterial brown spot of phalaenopsis



Typical symptoms of bacterial brown spot caused by
Acidovorax avenae subsp. *cattleyae*



Bacterial Brown Spot of Orchids

Pathogen : *Acidovorax avenae subsp. cattleyae*
(Synonym : *Pseudomonas cattleyae*)

Phylum: Proteobacteria

Class: Beta Proteobacteria

Order: Burkholderiales

Family: *Comamonadaceae*

Genus: *Acidovorax*

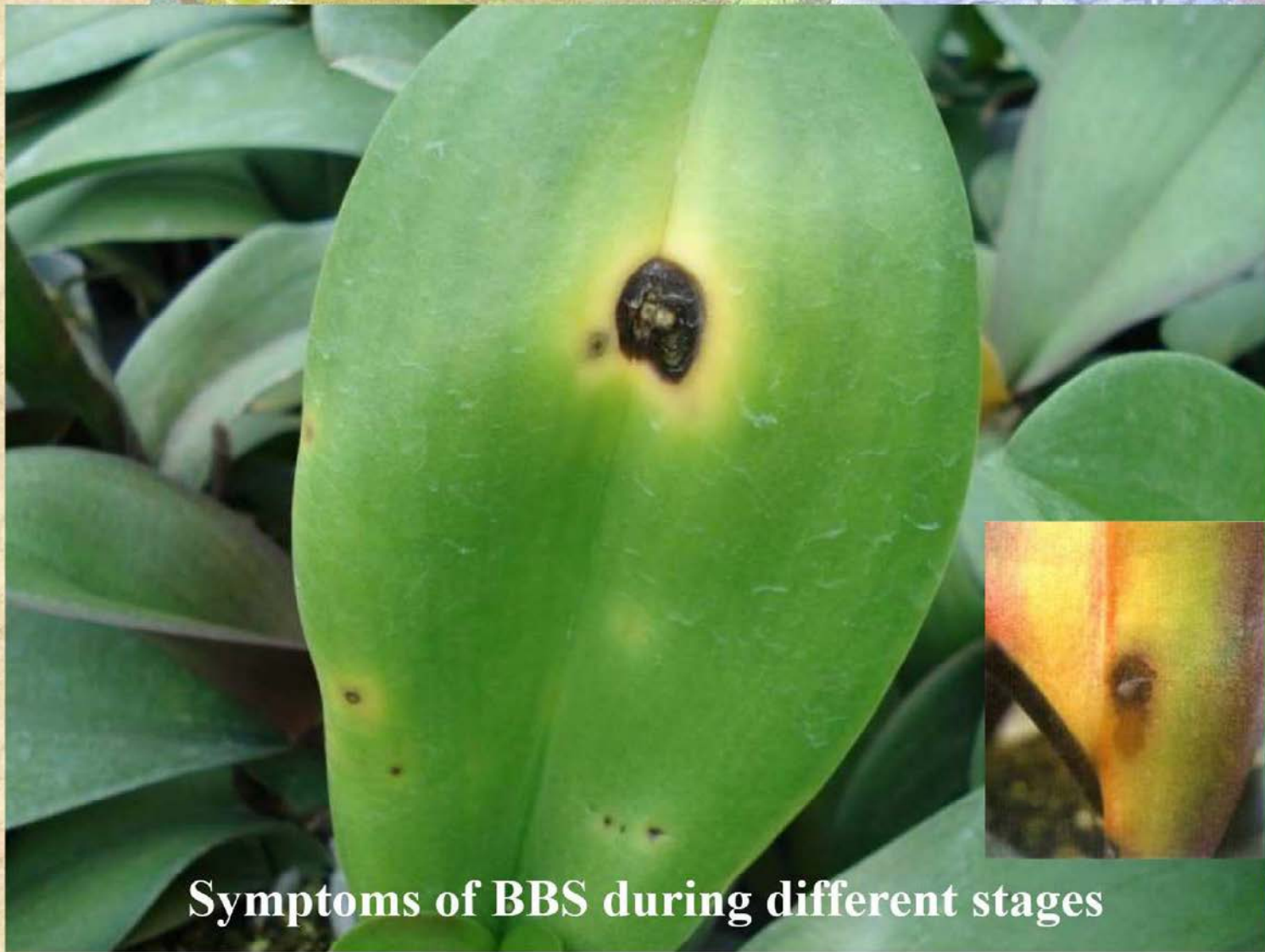
- ◆ Previous name — *Pseudomonas cattleyae*
- ◆ Nominated as *Acidovorax avenae subsp. cattleyae* by Willems *et al.* 1992



Facts about Bacterial Brown Spot (褐斑病)

- The first symptoms on *Phalaenopsis* are **soft, water-soaked lesions** which eventually become **sunken and brown to black** in color. Infection on older plants may occur anywhere on the leaf, and can kill the plant if it reaches the growing point. Diseased areas sometimes show a considerable amount of exudate, which contains infectious bacteria that may be **carried to other plants by splashing water**. Warm (24~28°C) and humid conditions favor the occurrence of the disease.
- Geographical distribution: Philippines, Taiwan, Italy, USA (Florida, CA), possibly Portugal and **other orchid-growing areas** ?
- Transmission: Bacterial exudate (ooze) from heavily infected plants may act as source of inoculum.
- Preliminary diagnosis: Observation of symptoms; Observation of **bacterial streaming** from diseased tissue with microscope.





Symptoms of BBS during different stages

Symptoms of BBS Varies Among Different Varieties of Phalaenopsis



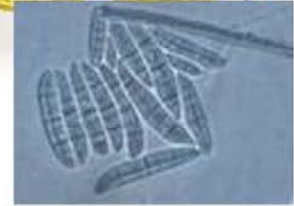


Control of Bacterial Brown Spot of Orchids

- Sound horticultural practices and stringent sanitation and plant hygiene in the nursery or glasshouse.
 - ◆ Avoid dense arrangement of orchid plants; remove weeds and other plants
 - ◆ Cut off and destroy all leaves or entire plant showing infection
 - ◆ Avoid overhead watering
 - Timely application of proper bactericides
 - ◆ Antibiotics: tetracycline, streptomycin+tetracycline.
 - ◆ Copper compounds: cupric hydroxide, kasugamycin+copper oxychloride, etc..
- * It's found that most strains (~70%) of the pathogen in Taiwan were resistant to high dose of streptomycin.**



Yellow Leaf (黃葉病) of Orchids Caused by *Fusarium solani* - A Serious Problem in Shipment



Courtesy of Huang, J. H., TARI



Asci and Ascospores (Sexual Stage) of *F. solani*



Courtesy of Huang, J. H., TARI



Asci & ascospores

植物防

Basal Rot (基腐病) of Orchids Caused by *F. oxysporum* -- A Serious Problem Particularly in Shipment



Courtesy of Huang, J. H., TARI

行政院農業委員會動植物防疫檢疫局





Basal rot of phalaenopsis

Basal Rot and Leaf Spot of Cymbidium Caused by *Fusarium* spp.



行政院農業委員會動植物防疫檢疫局



Facts about *Fusarium* spp.

■ Taxonomic classification

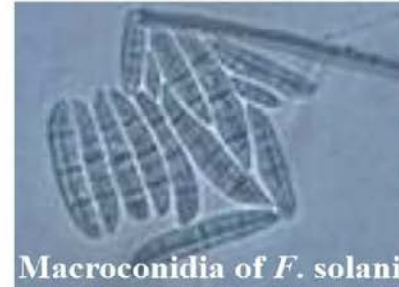


Kingdom: Fungi

Class: Deuteromycetes

Family: *Tuberculariaceae*

Genus: *Fusarium*



Macroconidia of *F. solani*

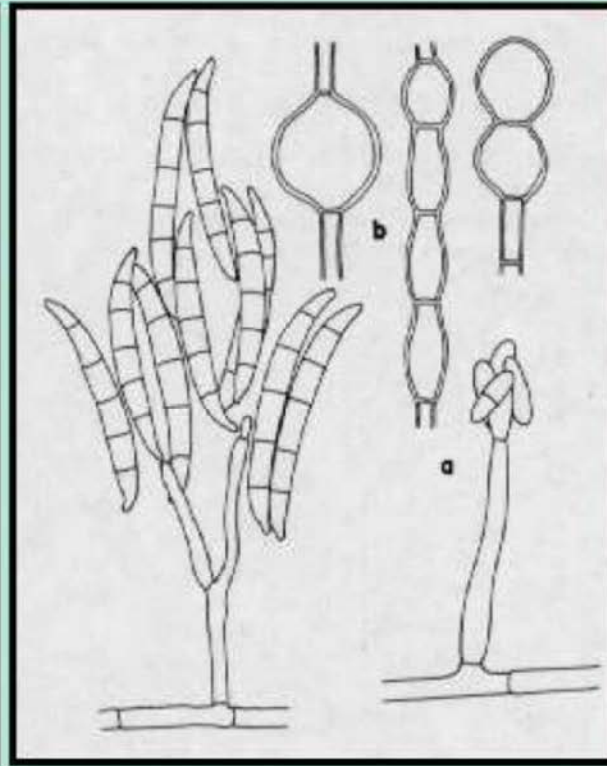
- *Fusarium* is a **filamentous fungus** widely distributed on plants and in the soil. Many species are **important plant pathogens** causing vascular wilt, yellows, and/or rot of plant parts. It's disseminated by **wet spores, insects, water splash, infested materials** including seeds and culturing media, and **wind** when dried out. Some *Fusarium* species have a teleomorphic state (sexual stage).

- Species of *Fusarium* typically produce macroconidia, microconidia, and chlamydospores. Microconidia are usually abundant, cylindrical to oval, 1- to 2-celled. Macroconidia are 3- to 5- septate (usually 3- septate), **canoe-shaped**). Chlamydospores are thick-walled and tolerant to unfavorable conditions.

- ◆ **Control:** **Removal and destruction of infected plants and growing media; Sterilization of growing media; Avoidance of excessive watering. Chemical control not recommended.**



Different Types of Spores of *Fusarium*



<http://www.botany.utoronto.ca/ResearchLabs>

Please do not distribute

a. Microconidia

b. Chlamydoconidia (thick-walls)

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Effect of Steam Sterilization

Lethal temperatures for soil microbes and weeds

Lethal temperature (°C)	Soil microbes
100	All pathogenic microbes and weeds
93	Heat-tolerance viruses, actinomycetes and weeds
82	Most weeds and viruses, all plant pathogens
60-71	Most plant pathogenic fungi and bacteria, insects, mites, earthworms, snails, centipedes
49-60	<i>Rhizoctonia solani</i>
49	Nematodes
38-49	Algae

Courtesy of Dr. Lee, M. L., TACTRI



Steam Sterilization of Soil

(A) 500L steamer. (B) steam exiting from the tips. (C) Soil sterilization (80°C , 30 min.) significantly controls **lily yellowing disease** caused by *Fusarium oxysporum* f. sp. *lilii*



Courtesy of Dr. Lee, M. L., TACTRI



行政院農業委員會動植物防疫檢疫局





Sterilization of sphagnum moss with hot water (80°C , 30 min.)



蘭花基腐病、黃葉病

病原菌：*Fusarium* spp.

- 發生逐漸普遍，嚴重影響輸美蘭株的良率。
- 通常感染根部或基部，導致腐敗及黑色壞疽，葉片則隨之黃化繼而死亡。
- 生長最適溫度約28°C，在栽植密度高、噴灌頻繁、通風不良的蘭園中，發生最為嚴重。
- 防治方法
 - ◆ 加強栽培介質衛生—蒸熱處理或熱水浸泡(80 °C, 30分鐘)
 - ◆ 避免過度噴灌；清除病株(附帶介質)。
 - ◆ 可能有效藥劑：撲克拉錳、撲克拉、銅合腐絕、得克利、賽普護汰寧。



Black Rot (黑腐病或疫病) of Orchids

Pathogen: *Phytophthora palmivora* or *P. parasitica*

Kingdom: Chromista

(Fungallike organisms including brown algae, diatoms, etc.)

Phylum: Oomycota

Class: Oomycetes

Order: Peronosporales

Family: *Pythiaceae*



- Cell walls composed of glucan and small amount of hydroxyproline and cellulose **without chitin**; Mycelium well-developed, **nonseptate** branching, inter- or intracellular, usually white-colored.
- ◆ **Mycelium**: The hypha or mass of hyphae that make up the body of a fungus.

Phytophthora Diseases of Orchids

Black rot (黑腐病或疫病)

Phytophthora parasitica
& *P. palmivora*

Phytophthora palmivora



Phalaenopsis



Oncidium



Release of zoospores

Courtesy of Dr. Hseih, T. F., TARI

行政院農業委員會動植物防疫檢疫局

Occurrence and Control of *Phytophthora* Disease

- The optimum temperature range for infection and black rot development is **27 to 30°C**; The optimum temperature for sporulation on the diseased tissue surface is 24°C.
- **Free moisture** is necessary for pathogen spread. Sporangia need to be in water in order to germinate or release zoospores. **Splashing water** from raindrops or irrigation helps to move spores from infected plants to nearby healthy plants. The motile **zoospores can swim** in pools of standing water, drainage ditches or irrigation systems to infect plants far away from the original disease site.
- Control measure
 - ◆ Horticultural practices: Refer to the prevention of bacterial diseases.
 - ◆ Chemical control: **For reference only**
Mancozeb , maneb, propineb, metiram, basic copper sulfate, cupric hydroxide, famoxadone+cymoxanil, cyazofamid, azoxystrobin, dimethomorph, chlorothalonil, mancozeb +metalaxyl, **neutralized phosphorous acid** ($H_3PO_3+KOH= 1:1$).



Control of *Phytophthora* Disease in oncidium with Neutralized Phosphorous Acid



Courtesy of Dr. Ann, P. J., TARI

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蘭花黑腐病(疫病)



病原：卵菌類 *Phytophthora palmovora*、*P. parasitica* 等。
菌絲無隔膜；含纖維素 cellulose 及葡聚糖 glucan
；無幾丁質(chitin)

■ 溫暖潮濕容易發生的卵菌類病害

疫病(*Phytophthora*)；腐霉病、腰折病(*Pythium*)。

露疫病(*Peronophythora*)

白銹病(*Albugo*)— 溫暖、潮濕

■ 涼冷潮濕容易發生：露菌病、晚疫病

* 防治藥劑 — 滅達樂、達滅芬、毆殺斯、依得利、克收欣、亞托敏、百克敏、鋅錳克絕、凡殺克絕、福賽得、殺紋寧、銅劑、大生類等。(其他殺真菌劑通常無效)

* 亞磷酸(以KOH調成pH6.8)預防效果相當優良。



Gray Mold (灰黴病) of Orchids Caused by *Botrytis cinerea*



Facts about *Botrytis cinerea*

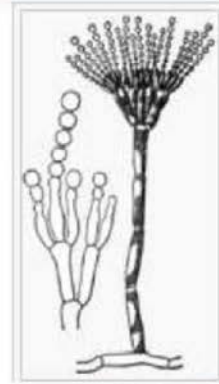
Kingdom: Fungi

Phylum: Ascomycota

Class: Deuteromycetes

Order: Hypomycetales

Family: *Moniliaceae*



Conidia on
conidiophores

From Wikipedia,
the free encyclopedia

- *B. cinerea* is characterized by abundant hyaline **conidia** (asexual spores) borne on grey, branching tree-like **conidiophores**. The fungus also produces highly resistant **sclerotia**, **compact masses of hyphae**, as survival structures in older cultures. It overwinters as sclerotia or intact mycelia, both of which germinate in spring to produce conidiophores. The teleomorph (sexual form) is an ascomycete, *Botryotinia cinerea*, which is rarely observed in nature.
- It can infect many plants including: grape, strawberry, lily, chrysanthemum, marigold, sunflower, sweet pea, zinnia, orchids, etc. and the diseases are known as **gray mold** or *Botrytis blight*.

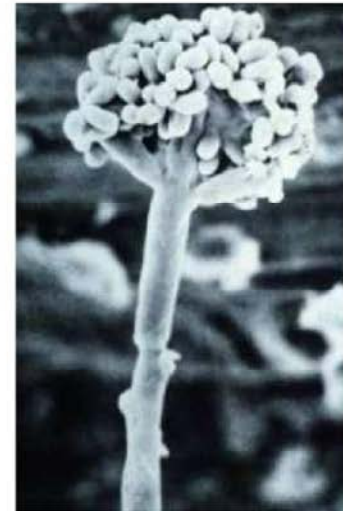


Facts about *Botrytis cinerea* (cont.)

- The conidia are dispersed by **wind and rain-water** and cause new infections. Its infections are favored by cool, rainy spring and summer weather usually around 15 °C. Gray mold can be particularly damaging when rainy, drizzly weather continues over several days.



Courtesy of Dr. Kuo, K. C., BAPHIQ



Conidia on conidiophores
observed with EM



Management Strategies for Gray Mold of Orchids

- Removal of faded or diseased flowers, or entire plants infected.
- Avoidance of overhead irrigation.
- Proper chemical control
Fungicides for reference:
 - ◆ 50% Iprodine (依普同) WP 1,500X
 - ◆ 50% Procymidone (撲滅寧) WP 2,000X
 - ◆ 70% Thiophanate methyl (甲基多保淨) WP 1,500X



Effect of different fungicides on the control of phalaenopsis gray mold

Chemical treatment	Disease severity (%) [※]	
	14 days after 4 th treatment	25 days after 4 th treatment
50% Iprodine WP 1,500X	1.4 ^a	1.8 ^a
50% Procymidone WP 2,000X	4.2 ^b	8.7 ^b
70% Thiophanate methyl WP 1,500X	14.2 ^b	29.6 ^b
50% Vinclozolin WP 1,500X	Flowers faded	Flowers faded
70% Metiram + Vinclozolin WP 500X	Flowers faded	Flowers faded
Control	29.2 ^c	58.2 ^c

※ Data are the means of 4 replicates, 20 flowers investigated in each treatment. Numbers followed by the same letter in the same column are not significantly different according to DMRT (p+0.01). Flowers faded due to the phytotoxicity caused by the fungicides applied.



蝴蝶蘭灰黴病防治試驗



藥 劑 處 理	灰黴病罹病度 (%) [*]	
	第4次施藥後14天	第4次施藥後25天
50%依普同 WP1,500倍	1.4 ^a	1.8 ^a
50%撲滅寧 WP2,000倍	4.2 ^b	8.7 ^b
70%甲基多保淨 WP1,500倍	14.2 ^b	29.6 ^b
50%免克寧 WP 1,500倍	花朵乾枯	花朵乾枯
70%免得克寧 WP 500倍	花朵乾枯	花朵乾枯
不施藥對照	29.2 ^c	58.2 ^c

※試驗時於初花期開始噴藥，每隔10天一次，連續四次。罹病度中的英文字母相同者，表示差異不顯著(P=0.01)。“—”表示藥害導致花朵脫水並提早掉落。62.5%賽普護汰寧可濕性粒劑1,500~2,000倍也可試用看有無藥害。



蘭花灰黴病

病原菌：*Botrytis cinerea* (不完全菌)

- 花容失色—是花器上最重要的病害。
- 感染花朵後首先出現浸狀小點，後轉為褐~暗褐色，濕度高時小點滋生灰黑色黴狀物，嚴重花朵會提早枯萎掉落。
- 3~5月間最容易發生，以濕度過高、管理不良的蘭園中最为猖獗。
- 防治方法
 - ◆ 妥切的蘭園管理：避免過濕。
 - ◆ 有效藥劑：**甲基多保淨、撲滅寧、依普同**（應輪流換用）。



Southern Blight of Orchids Caused by *Sclerotium rolfsii*

- *S. rolfsii* is a club fungus that can cause a variety of diseases in plants, including wilt and Southern Blight.
- It grows on plants and culture media as a **dense, downy, white mass**, infection results in it root, tuber rot, and/or basal rot.
- The agent is soil-borne and survives in soils as **sclerotia**, compact masses of hyphae.
- ◆ It's not commonly found in well-managed nursery or glasshouse; follow the strategies recommended for the control of *Fusarium* diseases, if necessary.



蘭花白絹病



● 防治方法

- ◆ 加強田間衛生，避免菌核殘留。
- ◆ 尿素土壤消毒
- ◆ 化學防治 — 菲克利、貝芬菲克利、脫克松、福多寧、待克利、依普座。

白絹病菌菌核



Effective fungicides for the Control of Southern Blight and Gray Mold (Sclerotium-forming Fungi)

■ Dichlorophenyl dicarboximide類

依普同(iprodione)、免克寧(vinclozolin)、撲滅寧(procymidone)

■ 環狀炭氫化物(Aromatic compound)

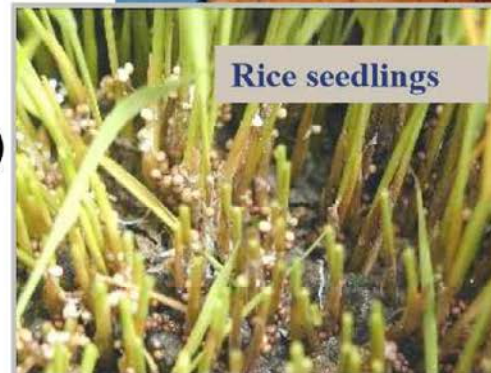
大克爛(dichloran)

■ 苯甲醯胺苯(benzanilide)類

滅普寧(mepronil)、福多寧(flutolanil)

■ 有機磷劑 (Organophosphate)

脫克松(tolclofos-methyl)



Discreet Use of Pesticides to Avoid Phytotoxicity



Ethoprophos (普伏松) application resulted in severe phytotoxicity



Oxamyl (毆殺滅) application resulted in severe phytotoxicity





Thanks for your attention