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**Australian Centre for  
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# TaroPest

An illustrated guide to  
pests and diseases of  
taro in the South Pacific

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pests and diseases of  
taro in the South Pacific

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Australian Centre for International  
Agricultural Research

2008

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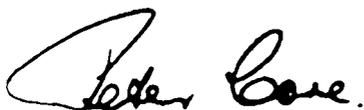
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## Foreword

Taro is a major crop of the South Pacific, with a regional production of more than 360,000 tonnes per year, and a wide cultural, economic and food security importance to nearly all Pacific island countries and territories. Given this importance, the Australian Centre for International Agricultural Research (ACIAR) and its partners have invested heavily over the years in enhancing the quality and sustainability of regional taro production. Unfortunately, taro is subject to significant losses from pests and diseases. The most important of these can devastate a previously unchallenged crop. For example, the introduction of taro leaf blight into Samoa in 1993 virtually eliminated that country's crop, causing economic hardship in rural areas, a destabilisation of internal food security and the loss of lucrative export trade.

To manage pests and diseases effectively, they need to be identified on crops so that biological and control information can be sourced. In the absence of suitable information, unknown exotic pests may establish in a region, or existing pests may be inappropriately treated. During the 2003 ACIAR South Pacific regional consultations, the lack of readily available information on taro pests was identified as a matter of concern. The development of a pest and disease tool kit for taro was subsequently agreed on as a regional priority. This led, in 2004, to the ACIAR project 'TaroPest: a computer-based information and diagnostics package for taro pests of the South Pacific' (CP/2004/001). This project combined the expertise of researchers from Fiji, Papua New Guinea and Australia initially, later expanding to include expertise from across the region.

As a summary of knowledge on the regional pests and diseases of taro, this monograph is an outcome of the TaroPest project, which itself built on many earlier taro pest-management projects. *'TaroPest: an illustrated guide to pests and diseases of taro in the South Pacific'* captures the work and knowledge of many researchers and field officers. We hope it will prove a valuable tool for taro producers, crop advisers and regional quarantine officers.

A handwritten signature in black ink, appearing to read 'Peter Core', with a large, stylized initial 'P'.

Peter Core

Chief Executive Officer

Australian Centre for International Agricultural Research

# Acknowledgments

*TaroPest* is a collaborative work. It includes contributions from researchers beyond those in the authorship list. Authors of individual fact sheets and suppliers of all photographs are listed in the associated CD. We thank the many regional scientists, extension staff and growers who provided feedback on *TaroPest* during its development, either through workshop participation, email discussion lists or individual contact. The developers of *TaroPest* would particularly like to acknowledge the important contributions made by: John Bridge, Fred Brooks, Jeff Daniells, Wolfgang Gerlach, Roger Goebel, Rowland Holmes, Gerald McCormack, Eric McKenzie, Jeri Ooka, George Wall, and Philip Tuivavalagi and other staff of the Samoan Ministry of Agriculture and Fisheries (Nu'u).

The *TaroPest* project was a joint collaboration between the Papua New Guinea National Agricultural Quarantine and Inspection Agency, the Secretariat of the Pacific Community Plant Protection Service and the Queensland University of Technology in Australia. Core funding was provided by the Australian Centre for International Agricultural Research (ACIAR), under ACIAR project CP/2004/001. Additional information on pests and diseases has been gathered from the following ACIAR projects: CP/1994/043, CP/2000/044, HORT/2007/037 and HORT/2006/053.

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# Introduction

Taro (*Colocasia esculenta*), which is a major food crop in the South Pacific, is subject to significant losses from pests and diseases. Most South Pacific taro pests have restricted distributions, making effective quarantine critical to their containment and management. Identifying pests already in a country is an ongoing requirement for growers, extension officers and those responsible for trying to gain international market access for the crop. Lack of user-friendly diagnostic tools, however, means that effective quarantine, pest management and pest surveillance are severely hampered. To overcome these problems, *TaroPest* has been developed as a guide to the pests and diseases of taro in the South Pacific. Its aim is to be a one-stop shop for pests of taro, with keys, fact sheets, photographs and other supporting information. *TaroPest* consists of a field guide and a self-running CD-ROM, which is interactive and contains information additional to that presented in the manual. The field guide is designed to be a portable printed version to be used in conjunction with the CD-ROM. Users risk missing out on useful information if they only consult the hard-copy part of *TaroPest*.

The *TaroPest* project was funded by the Australian Centre for International Agricultural Research (ACIAR). It was initially a collaborative project involving staff of the Secretariat of the Pacific Community Plant Protection Service, the (Papua New Guinea) National Agricultural Quarantine and Inspection Authority and the Queensland University of Technology in Australia. As the project developed, significant and valuable input was provided by private consultants, regionally located research and extension officers, and plant pest and disease specialists from around the world. To the best of our knowledge, *TaroPest* captures all available information pertinent to the identification and management of taro pests and diseases in the South Pacific region. Although we found that much is known about a small group of the insects and diseases attacking taro, *TaroPest* also highlights that, for the majority, little or nothing is known about their economic or biological impact, differences in susceptibility between different taro cultivars, and control methods. More research on these topics is needed.

While formal acknowledgments are given elsewhere in *TaroPest*, the authors wish to recognise here the funding and logistic support of ACIAR and our employer organisations. We would also like to particularly thank the many regional scientists, field officers, extension staff and growers whose photographs, firsthand knowledge and efforts in trialling *TaroPest* substantially increased its content, usability and accuracy.

# Identification key

1.
  - a) I can see a pest ..... 2
  - b) The plant is damaged or diseased, but I can't see a pest..... 14
2.
  - a) I found the pest in or on the corm ..... 3
  - b) I found the pest on the leaf blade or petiole..... 5
3.
  - a) I found the pest inside the corm tissue ..... Taro beetle (*Papuana* spp.) p. 46
  - b) I found the pest on the surface of the corm ..... 4
4.
  - a) A very small, soft-bodied insect associated with the plant roots, showing masses of white cottony thread ..... Taro root aphid (*Patchiella reaumuri*) p. 48
  - b) A soft, segmented insect covered with a white waxy powder, plant roots not covered with white cottony threads ..... Mealybugs (family Pseudococcidae) p. 44
5.
  - a) It is a caterpillar ..... 6
  - b) It is something other than a caterpillar ..... 7
6.
  - a) A green–brown to red–brown caterpillar with dark markings, without a horn on its tail ..... Armyworm (*Spodoptera litura*) p. 50
  - b) A bright green (occasionally reddish-brown) caterpillar, with a 'horn' on its rear end. It has two spots resembling eyes behind the head ..... Hornworm (hawk moth) (*Hippotion celerio*) p. 42
7.
  - a) It is a snail ..... Giant African snail (*Lissachatina fulica*) p. 62
  - b) It is something other than a snail..... 8
8.
  - a) I cannot see individual organisms without the use of a hand lens or microscope. Organisms smaller than 1 mm ..... 9
  - b) I can see individual organisms without the use of a hand lens or microscope ..... 11

9.		
a)	The organisms are green in colour . . . . .	Aphids ( <i>Aphis gossypii</i> ) p. 38
b)	The organisms are red in colour . . . . .	Spider mites ( <i>Tetranychus</i> spp.) p. 54
c)	The organisms are white or whitish-cream in colour. . . . .	10
10.		
a)	A spiralling pattern is apparent on the leaves or there is an abundance of wax present . . . . .	Spiralling whitefly ( <i>Aleurodicus dispersus</i> ) p. 36
b)	No spiralling pattern is present on the leaves, nor is there lots of wax present . . . . .	Tobacco whitefly ( <i>Bemesia tabaci</i> ) p. 40
11.		
a)	The organisms are coloured other than white . . . . .	12
b)	The organisms are white in colour . . . . .	13
12.		
a)	Small and robust insects, adults approximately 4 mm in length, generally black with broad white patches or markings . . . . .	Taro planthopper ( <i>Tarophagus</i> spp.) p. 52
b)	Small, pear-shaped insects with soft, fragile bodies, colour variable from pale green–yellow to dark green, sizes range from 1 mm to 2.5 mm . . . . .	Aphids ( <i>Aphis gossypii</i> ) p. 38
13.		
a)	A soft, highly segmented insect without an outer shell, covered with a white waxy powder, ovoid in shape, wings absent . . . . .	Mealybugs (family Pseudococcidae) p. 44
b)	A spiralling pattern is apparent on the leaves, or there is an abundance of wax present . . . . .	Spiralling whitefly ( <i>Aleurodicus dispersus</i> ) p. 36
c)	Small, distinctly winged insects, wings very white and body pale yellow, no spiralling pattern on the leaves, no free wax . . . . .	Tobacco whitefly ( <i>Bemesia tabaci</i> ) p. 40
14.		
a)	The corm or the roots are affected . . . . .	15
b)	The leaf blade or petioles are affected . . . . .	23
15.		
a)	There are signs of damage and holes in the corms . . . . .	Taro beetles ( <i>Papuana</i> spp.) p. 46
b)	The roots are distorted with galls or knots. .Root knot nematodes ( <i>Meloidogyne</i> spp.)	p. 58
c)	There are signs of disease and the corm appears rotten . . . . .	16
16.		
a)	The signs of disease were visible in the corms before harvest. . . . .	17
b)	The corms were healthy at harvest, so the rot has occurred since. . . . .	19

17.

- a) The plant quickly collapsed and rotten corms were discovered  
..... Bacterial soft rot (*Erwinia chrysanthemi*) p. 14
- b) The plant has shown gradual wilting or other symptoms leading to the discovery  
of corm rot..... 18

18.

- a) Corms show irregular zones of dry brown rot that originate from the base of the corm,  
healthy tissue adjacent to the rot is red and corms have the appearance of uncooked  
fatty meat ..... Miti miti disease (*Hirschmanniella miticausa*) p. 56
- b) Fans of white mycelia are growing over the infected area and (sometimes) the organic  
matter surrounding the plant; sclerotia from pale cream to reddish-brown are present  
at the site of infection ..... Corm rot (*Athelia rolfsii*) p. 16
- c) Diseased corms show a rot of varying colour from whitish-yellow, through shades of  
grey and blue, to dark purple, usually starting at the base of the corm; a sharp line  
of demarcation can usually be seen between healthy and diseased tissue when the  
corm is cut open ..... Corm soft rot (*Pythium* spp.) p. 34

19.

- a) The rot is soft and foul smelling ..... Bacterial soft rot (*Erwinia chrysanthemi*) p. 14
- b) The rot is not soft or foul smelling ..... 20

20.

- a) I am in a country where taro leaf blight (*Phytophthora colocasiae*) is present  
(American Samoa, Federated States of Micronesia, Guam, Commonwealth of  
Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands) .... 21
- b) I am not in a country where taro leaf blight (*Phytophthora colocasiae*) is present. .... 22

21.

- a) Light brown, hard rot ..... Taro leaf blight (*Phytophthora colocasiae*) p. 30
- b) White dry rot, often with a dark brown margin and large pink patches ahead of the  
rot margin ..... Corm soft rot (*Pythium* spp.) p. 34
- c) White-cream spongy rot darkening with age and sour smelling  
..... Spongy black rot (*Lasiodiplodia theobromae*) p. 20
- d) Pink with white, dense fungal growth after 24 hours at high humidity  
..... Corm rot (*Athelia rolfsii*) p. 16

22.

- a) White dry rot, often dark brown at the margin and large pink patches ahead of the  
rot margin ..... Corm soft rot (*Pythium* spp.) p. 34
- b) White-cream spongy rot darkening with age and sour smelling  
..... Spongy black rot (*Lasiodiplodia theobromae*) p. 20

c) Pink with white, dense fungal growth after 24 hours at high humidity .....	Corn rot ( <i>Athelia rolfsii</i> )	p. 16
23.		
a) The leaf has been chewed .....		24
b) The leaf has not been chewed .....		25
24.		
a) The surface of the leaf blade has been chewed .....	Armyworm ( <i>Spodoptera litura</i> )	p. 50
b) The feeding damage begins from the leaf edge .....	Hornworm ( <i>Hippotion celerio</i> )	p. 42
25.		
a) There are spots on the leaf .....		26
b) There are no spots on the leaf; the leaf is damaged some other way .....		31
26.		
a) The spots are minute .....	Spider mites ( <i>Tetranychus</i> spp.)	p. 54
b) The spots are not minute .....		27
27.		
a) The spots are mostly small (15 mm) on older leaves .....		28
b) The spots are not mostly small .....		30
28.		
a) The spots are white .....	White spot of taro ( <i>Leptosphaerulina trifolii</i> )	p. 22
b) The spots are yellow, brown or orange (or a combination of these colours) .....		29
29.		
a) There are spots mainly on older leaves; yellowish-brown, circular or irregular blotches on either leaf surface, sometimes surrounded by a yellow halo, or with a brown border; spots are up to 15 mm in diameter, but smaller when there are many spots on one leaf .....	Orange leaf spot ( <i>Neojohnstonia colocasiae</i> )	p. 26
b) Brown leaf spot, mainly on older leaves; reddish-brown, circular or irregular, diffuse blotches on either leaf surface, sometimes with a blackish, diffuse centre; sometimes blotches are surrounded by a yellow halo or have a dark brown, diffuse border; spots are up to 15 mm in diameter, but much smaller when there are many spots on one leaf .....	Ghost spot ( <i>Cladosporium colocasiae</i> )	p. 18
c) There are indistinct, circular spots up to 15 mm in diameter, yellow–reddish discolouration on the upper surface of the leaf, with black mould growth on the corresponding lower surface; on upper leaf surfaces in the early stages, spots appear whitish-green and powdery .....	Leaf blotch ( <i>Pseudocercospora colocasiae</i> )	p. 32

- 30.
- a) The first sign of the disease is a small circular speck, brown on the upper leaf surface and water-soaked below; later, larger spots that are circular in shape, dark brown and with yellow margins appear . . . . . Taro leaf blight (*Phytophthora colocasiae*) p. 30
  - b) The first symptoms are small, round brown spots on the second or third leaves; as the spots enlarge to 2 cm in diameter, the brown centres fall out; the holes have a narrow, brown margin that is surrounded by an intense yellow ring (halo) . . . . . Shot hole (*Phoma* spp.) p. 28
- 31.
- a) The taro plant is showing signs of wilting . . . . . 32
  - b) The taro plant is distorted and/or stunted . . . . . 37
  - c) The taro leaf has patches of yellow to light green on or between veins. . . . . 38
- 32.
- a) There are lots of insects present . . . . . Taro planthopper (*Tarophagus* spp.) p. 52
  - b) There are no insects present . . . . . 33
- 33.
- a) The plant collapsed quickly . . . . . Bacterial soft rot (*Erwinia chrysanthemi*) p. 14
  - b) The plant gradually succumbed to a disease. . . . . 34
- 34.
- a) There are no signs of fungal growth at the base of the plant . . . . . 35
  - b) There are signs of fungal growth at the base of the plant. . . . . 36
- 35.
- a) Corms show irregular zones of dry brown rot that originate from the base of the corm; healthy tissue adjacent to the rot is red and corms have the appearance of uncooked fatty meat . . . . . Miti miti disease (*Hirschmanniella miticausa*) p. 56
  - b) There are darkened areas of dead tissue on roots and corms . . . . . Lesion nematode (*Pratylenchus coffeae*) p. 60
- 36.
- a) Leaves collapse due to the development of large brown rots at the base of the plant, associated with white fungal growth; the leaves are often stuck together by fungal threads (mycelia); toadstools form in large numbers on the withered leaves at the soil level . . . . . Corm and leaf spot (*Marasmiellus stenophyllus*) p. 24
  - b) Fans of white mycelia grow over the infected area and (sometimes) the organic matter surrounding the plant; sclerotia from pale cream to reddish-brown in colour are usually present at the site of infection . . . . . Corm rot (*Athelia rolfsii*) p. 16

37.

- a) Severe stunting occurs with distorted, brittle leaves, which sometimes fail to unfurl; in some cases, leaves show dark green wrinkled patches, mostly between the major veins; galls may be present on the petioles and sometimes the larger veins ..... *Colocasia* bobone disease virus (CBDV) p. 66
- b) Initial symptoms vary: either plants are similar to those infected with CBDV, showing stunted, thickened, twisted, dark green leaves, or plants are stunted with leaf blades bent under at the tip; in either case, the plants collapse rapidly and the leaves appear splayed (as if they are wilting). ..... *Alomae* p. 64
- c) Plants are small, stunted and have severely distorted leaves; some leaves are reduced to strap-like structures without leaf blades. .... *Dasheen* mosaic virus (severe strain) p. 68

38.

- a) Leaves show distinct vein chlorosis; as the leaves age, the chlorosis spreads between the veins, which form a network ..... *Taro* vein chlorosis virus p. 72
- b) Plants show a variety of mosaic patterns: small, irregular, scattered, grey, green or yellow (sometimes white) patches along or between the major veins, or brilliant white or yellow feather-like patterns along the veins ..... *Dasheen* mosaic virus p. 68
- c) Indistinct areas of vein chlorosis are present, often near the leaf margin; frequently, the leaf blades are bent backwards, and sometimes puckered ..... *Taro badnavirus* p. 70

## Fact sheets

The text and illustrations in the following sections are abbreviated versions of those available on the CD. For this field guide, we have concentrated on the presentation of field photographs, as an aid to in-field diagnosis. While we hope this will lead to rapid, positive identifications, we encourage users to confirm pest identifications using the CD, which has a more complete set of diagnostic images. The CD also contains significantly more text on a wider range of topics than is presented here (see also 'How to use the *TaroPest* CD' on page 74).

## Bacteria

# Bacterial soft rot

## *Erwinia chrysanthemi*

### What is it?

*Erwinia chrysanthemi* is a bacterium that causes a soft rot of corms in the field and in storage.

### Where is it found?

*Erwinia chrysanthemi* has been recorded on taro in Solomon Islands and on other host plants in Cook Islands and Papua New Guinea.

### What does it do?

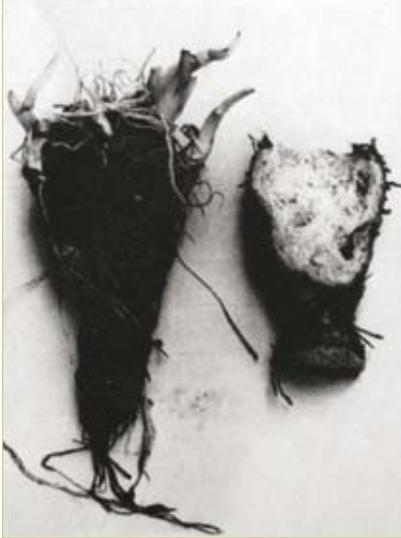
In the field, infection causes a foul-smelling, creamy-white corm soft rot, and plants wilt suddenly. A similar rot occurs in harvested corms stored at high temperature and humidity. In Solomon Islands, soft rot is associated with plants infected by *Pythium myriotylum*, sometimes together with *P. splendens*.

### What do I look for?

A sudden collapse of the leaves of mature plants is often indicative of bacterial soft rot of the corm. Leaf collapse occurs in plants that have wilted due to root infection by *Pythium* spp. At this stage, corms are usually so decayed that plants can topple over in the wind. In storage, in soil-pits or plastic bags, the bacterium can be detected by the presence of soft rot with a strong, unpleasant smell.

### How do I control it?

There are no specific measures to prevent field infections of *Erwinia chrysanthemi*, and the low incidence of the rot in taro planting precludes efforts to find any. However, the 'tops'—the petiole base with corm piece—from corm-rot affected plants should not be used as propagating material. Rots are more important in corms stored at high humidities, either in soil-pits or in plastic bags. This type of storage would otherwise extend the shelf life by preventing infection from *Phytophthora colocasiae*, *Pythium splendens* and *Lasiodiplodia theobromae*. A reduction in the incidence of these types of rots is possible if corms are pretreated with bleach (1% sodium hypochlorite).

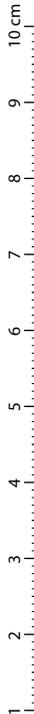


**ABOVE:** *Erwinia chrysanthemi*, a bacterium that causes a soft rot of corms in the field and in storage: left, healthy corm; right, corm infected with bacterial soft rot.



**TOP:** Taro infected with *Erwinia chrysanthemi*, before collapse.

**BOTTOM:** Taro infected with *Erwinia chrysanthemi*; note collapse of plant.



# Fungi

## Corm rot

### *Athelia rolfsii*

#### What is it?

*Athelia rolfsii* is a soil-borne fungus that infects taro at the soil level, causing corms and roots to rot and leaves to wilt.

#### Where is it found?

Corm rot has been recorded in American Samoa, Cook Islands, Fiji, French Polynesia, Federated States of Micronesia, New Caledonia, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu, and Wallis and Futuna.

#### What does it do?

Infection starts at the soil level, at the base of the petioles. Fans of white mycelia grow over the infected area and sometimes on nearby organic matter. Leaves often wilt. The disease is characterised by the presence of more dead leaves than normal. Pale cream to reddish-brown sclerotia of 1–2 mm in diameter are usually present at the site of infection. The fungus also causes a postharvest pinkish corm rot, infecting corms through wounds made when suckers are detached.

#### What do I look for?

In taro plants with wilted leaves, the base of the petioles at soil level should be inspected for white mycelia and sclerotia. *Athelia rolfsii* is quite distinct on wilted plants, but could be confused with *Marasmiellus stenophyllus* if the plants are dead. The way to distinguish between them is the presence of either basidiocarps (toadstools) for *M. stenophyllus* or sclerotia for *A. rolfsii*.

#### How do I control it?

**Cultural control and sanitary methods:** *Athelia rolfsii* is a major pathogen of several crops, more so than taro; thus, a number of control measures have been developed, some of which may be applicable to taro, including:

- ▶ removing and destroying infected plants by burning
- ▶ applying good cultural practices—for example, deep ploughing and encouraging the growth of micro-organisms (especially *Trichoderma* spp.) that inhibit fungal growth
- ▶ using soil solarisation—covering the soil with plastic and allowing the sun to heat the trapped air
- ▶ liming the soil
- ▶ applying fungicides
- ▶ using crop rotation.

**Integrated pest management programs:** Crop rotation with non-hosts or tolerant hosts can greatly reduce numbers of infective propagules in a field, although the sclerotia can remain viable for many years. Cereal crops (Poaceae) are relatively resistant to the fungus.



**TOP:** Severe wilting and leaf death associated with infection by *Athelia rolfsii*.

**MIDDLE:** Wilt of taro associated with infection by *Athelia rolfsii*; note the older leaves are dead or dying.

**BOTTOM:** Sclerotia (arrow) and white mycelia of *Athelia rolfsii*.

**TOP:** Sclerotia of *Athelia rolfsii*.

**MIDDLE:** Mycelium growing over the base of the petiole and the fringe of white sclerotia at the soil level.

**BOTTOM:** A corm infected with *Athelia rolfsii* after incubation at high humidity for 24 hours.

## Fungi

# Brown leaf spot (or ghost spot)

## *Cladosporium colocasiae*

### What is it?

Brown leaf spot is a fungal disease of older leaves. It is also called ghost spot because the lesions are often less evident on the opposite surface of the leaf. This leaf spot causes symptoms very similar to those of *Neojohnstonia colocasiae* (orange leaf spot). In addition, leaf blotch (*Pseudocercospora colocasiae*) occurs together with *Cladosporium colocasiae* in Samoa and, on symptoms alone, these are difficult to tell apart.

### Where is it found?

*Cladosporium colocasiae* is widely distributed throughout the Pacific.

### What does it do?

*Cladosporium colocasiae* causes brown leaf spot (or ghost spot) of older leaves—reddish-brown, circular or irregular, diffuse spots or blotches on either leaf surface, sometimes with dark, diffuse centres. The spots are usually less evident on the opposite surface of the leaf. Sometimes the spots are surrounded by a yellow halo or have a dark brown, diffuse border. Spots can be up to 15 mm in diameter, but are usually much smaller when there are many spots on a single leaf.

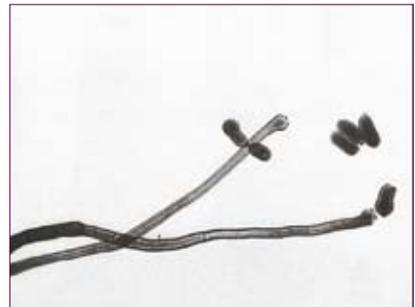
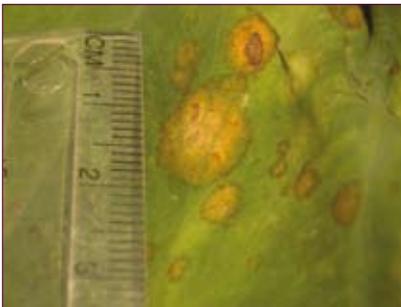
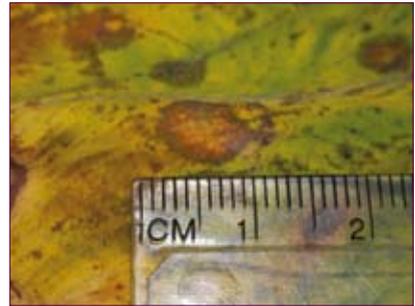
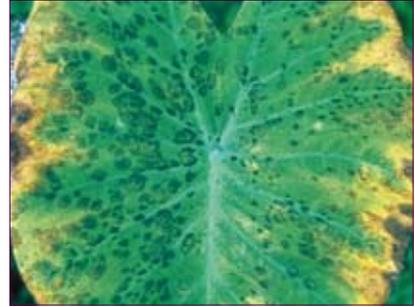
### What do I look for?

Microscopic examination is necessary for identification. Spores can be lifted off the leaf using a scalpel to scrape the surface, or using clear adhesive tape, by pressing a piece gently over the spot and lifting it off the leaf surface. The spores can then be mounted in a drop of water on a microscope slide for identification under a compound microscope. The conidiophores (stalks that bear the spores) are straight or bent, with spores (conidia) that are formed on swellings at the end. The spores are cylindrical to oblong, rounded at the end, often constricted in the middle, with up to three cross walls.

### How do I control it?

**Phytosanitary measures:** Plant quarantine authorities might require certification that consignments of leaves are free from this pathogen when leaves are moved internationally. However, it is not considered to be a pest of 'potential economic importance'.

**Cultural control and sanitary methods:** No control is required; however, removal and destruction by burning of infected leaves will reduce inoculum levels.



**TOP:** Brown leaf or ghost spots with dark centres and blackish borders as sporulation occurs and the spots age.

**MIDDLE:** The pale greenish-yellow spots on the top surface are showing through from spots on the bottom surface of the leaf.

**BOTTOM:** Yellow–orange ghost spots; spots are variable in colour.

**TOP:** The spots darken with age and at the margins of the leaf they merge, turn brown and dry out.

**MIDDLE:** Brown leaf or ghost spots with dark brown, diffuse borders, up to 15 mm in diameter.

**BOTTOM:** *Cladosporium colocasiae* conidiophores are straight or bent; spores form on swellings at the ends.



## Fungi

# Spongy black rot

## *Lasiodiplodia theobromae*

### What is it?

*Lasiodiplodia theobromae* in taro corms causes a postharvest rot that is initially whitish-cream, later becoming blue–black.

### Where is it found?

*Lasiodiplodia theobromae* has been recorded on taro in Guam, Papua New Guinea, Samoa and Solomon Islands. It has been recorded on other host plants in American Samoa, Australia, Cook Islands, Fiji islands, French Polynesia, Federated States of Micronesia, New Caledonia, New Zealand, Niue, Palau, Papua New Guinea, Tonga, Vanuatu, and Wallis and Futuna.

### What does it do?

*Lasiodiplodia theobromae* is frequently isolated in decayed corm tissues behind advancing rots caused by *Phytophthora colocasiae* and *Pythium splendens*. Even in the absence of other fungi, it enters corms through wounds made during harvest and causes complete decay in 10–14 days. *Lasiodiplodia theobromae* causes a spongy rot, which occasionally becomes dry and powdery, with an indistinct margin between healthy and diseased tissue.

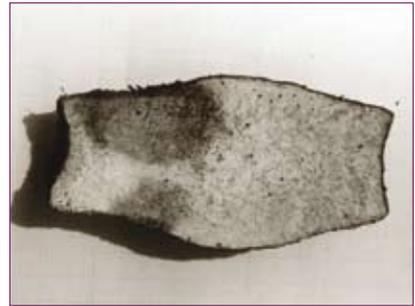
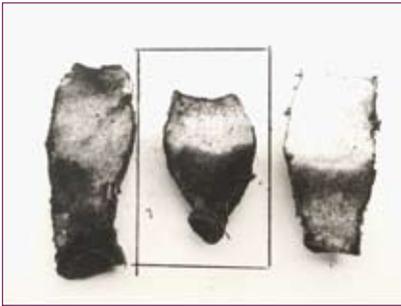
### What do I look for?

Spongy black rot can be detected by cutting the corm to reveal the black interior; it has a strong, sour smell and black spore masses form on the corm surface.

### How do I control it?

**Chemical control:** Dipping corms in bleach (1% sodium hypochlorite) for 2 minutes before storing in polyethylene bags is effective in controlling this fungus.

**Traditional practices:** The traditional practice of the Sikaiana Island people (of Polynesian descent) is to store taro for up to 4 weeks buried in pits situated in shaded, well-drained soil.



**TOP:** *Lasiodiplodia theobromae* in taro corms, showing advanced decay.

**MIDDLE:** *Lasiodiplodia theobromae* in taro corms.

**BOTTOM:** Initial rot is caused by *Pythium* sp., a dry and crumbly white rot, which is colonised by *Lasiodiplodia theobromae*, becoming purple.

**TOP:** Taro corm rot caused by *Lasiodiplodia theobromae*; the rot is initially white, later turning black and spongy.

**MIDDLE:** *Lasiodiplodia theobromae* in a taro corm.

**BOTTOM:** Spore-containing structures (pycnidia) form on the corm surface as the rot proceeds.

# Fungi

## White spot of taro

### *Leptosphaerulina trifolii*

#### What is it?

*Leptosphaerulina trifolii* produces yellow spots on taro leaves. These later turn white. Spots sometimes merge and show 'shot hole' symptoms as the centres fall out.

#### Where is it found?

*Leptosphaerulina trifolii* has been recorded on taro in American Samoa, Papua New Guinea, Samoa, Solomon Islands and Tuvalu. It is found on other hosts in Fiji, Marshall Islands, Niue, Tonga and Vanuatu.

#### What does it do?

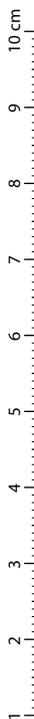
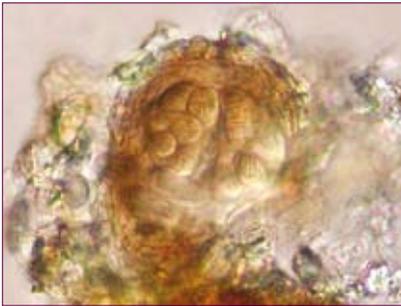
Infections are initially visible as small, yellow-green spots on the upper leaf. As spots mature, they become edged by a thin (1 mm), reddish-brown border and surrounded by an intense yellow halo, 1–2 mm wide. Mature lesions are 2–5 mm in diameter with paper-white centres. Small, black fruiting bodies can be seen on close observation against the white tissue of mature lesions. Centres often fall out, creating a 'shot hole' appearance. In severe infections, spots may coalesce, and the leaves look tattered.

#### What do I look for?

White spot is visible as small, white spots with yellow haloes on the upper leaf surface. A hand lens will reveal the small, brown-to-black fruiting bodies (pseudothecia). Fruiting bodies of this fungus are easily extracted from lesions. Pseudothecia are relatively small (approximately 125 µm in diameter), asci are usually sac-like (saccate), and most multicelled ascospores have longitudinal and cross septae (dictyospores).

#### How do I control it?

Control measures are usually not necessary. The impact of this disease is very low. In American Samoa, only a few plants have been seen to be severely infected (25–50% leaf area) and usually the disease is unremarkable.



**TOP:** Two leaves heavily infected by *Leptosphaerulina trifolii*; note, most other leaves are not infected.

**MIDDLE:** A fruiting body of *Leptosphaerulina trifolii* with asci and spores visible through its wall.

**BOTTOM:** Early symptoms of *Leptosphaerulina trifolii* infection at the margin of a taro leaf.

**TOP:** Fruiting bodies and spores of *Leptosphaerulina trifolii* isolated from giant taro (*Alocasia macrorrhizos*).

**MIDDLE:** Severe infection; note the white centres of the spots and the 'shot hole' effect.

**BOTTOM:** Double-walled, sac-like asci of *Leptosphaerulina trifolii*, each containing eight spores.

# Fungi

## Corm and leaf spot

### *Marasmiellus stenophyllus*

#### What is it?

*Marasmiellus stenophyllus* infects taro at the base of the plant, destroying leaves, corms and roots, and commonly producing toadstools on the dying parts.

#### Where is it found?

*Marasmiellus stenophyllus* has been recorded on taro in American Samoa, French Polynesia, and Wallis and Futuna, and on other hosts in Fiji.

#### What does it do?

Corm and leaf spot caused by *Marasmiellus stenophyllus* leads to leaf collapse due to the development of large brown rots at the base of the plant associated with white fungal growth. The leaves are often stuck together by the fungal threads (mycelia). Toadstools form in large numbers on the withered leaves at soil level. The fungus grows over the roots and kills them, and soil particles become fastened to the roots in the process. Infection with *M. stenophyllus* can kill the plant, which appears desiccated or mummified. Corms become inedible and, even at an early stage of decay, may be unsightly with mycelium growth causing small 'pocket' rots. However, the incidence of infection is low.

#### What do I look for?

If plants have wilted or are growing slowly compared with others, check for toadstools growing from the dead or dying petioles. The roots will appear dirty with soil, and debris will be adhering to them in clumps that cannot be removed even after gentle washing. *Marasmiellus stenophyllus* is quite distinct on taro, but could be confused with *Athelia rolfsii* on completely dead plants. The way to distinguish between the two is to look for the presence of basidiocarps (toadstools) for *M. stenophyllus* and sclerotia for *A. rolfsii*.

#### How do I control it?

**Cultural control and sanitary methods:** The removal and destruction of infected plants by burning is helpful in controlling the fungus.



**TOP:** Toadstools of *Marasmiellus stenophyllus* growing from decayed leaves at the base of taro.  
**MIDDLE:** Plants with many dead leaves, killed by *Marasmiellus stenophyllus*.  
**BOTTOM:** Mycelium of *Marasmiellus stenophyllus* growing over taro roots and corm, trapping soil particles and leading to a 'dirty' appearance.

**TOP:** Late-stage infection of taro by *Marasmiellus stenophyllus*, showing matted leaves and mummified corm.  
**MIDDLE:** Toadstool of *Marasmiellus stenophyllus*.  
**BOTTOM:** 'Dirty roots'; the mycelia have grown over the roots and corm, trapping soil.



## Fungi

# Orange leaf spot

## *Neojohnstonia colocasiae*

### What is it?

Orange leaf spot is a fungal disease of older leaves causing symptoms very similar to those of *Cladosporium colocasiae* (brown leaf spot).

### Where is it found?

*Neojohnstonia colocasiae* has been recorded on taro in American Samoa, Fiji, Federated States of Micronesia, Palau, Papua New Guinea, Samoa, Solomon Islands, Tuvalu, Vanuatu, and Wallis and Futuna.

### What does it do?

*Neojohnstonia colocasiae* causes yellowish-brown, circular or irregular blotches on either leaf surface. These become darker with the onset of sporulation. Spots are sometimes surrounded by a yellow halo or have a brown border. They can be up to 15 mm in diameter, but tend to be smaller when there are many spots on a single leaf.

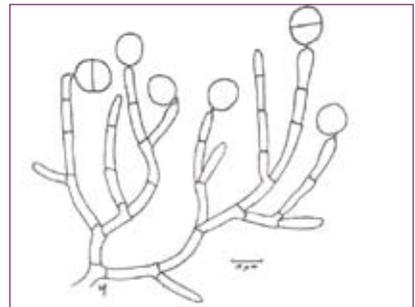
### What do I look for?

On the leaves, the spots can be seen with the naked eye, but microscopic examination is necessary for identification. Spores can be lifted off the leaf using a scalpel to scrape the surface, or using clear adhesive tape by pressing a piece gently over the spot and lifting it off the leaf surface. Spores can then be mounted in a drop of water on a microscope slide under a cover slip. The fungus can also be examined by culturing and inducing sporulation on artificial media. The conidiophores (stalks that bear the spores) are found mainly on the lower leaf surface—they are branched with single round spores (with a cross wall) connected to the conidiophores by a short, thin stalk.

### How do I control it?

**Phytosanitary measures:** Plant quarantine authorities might require certification that consignments of leaves are free from this pathogen when leaves are moved internationally. However, it is not considered to be a pest of 'potential economic importance'.

**Cultural control and sanitary methods:** No control measures are recommended; however, removal and destruction by burning of infected leaves will reduce inoculum levels.



**TOP:** Leaf spots of *Neojohnstonia colocasiae* on taro, darkening as sporulation occurs.

**MIDDLE:** *Neojohnstonia colocasiae* spots also form on the undersides of leaves and develop brown centres as sporulation occurs.

**BOTTOM:** Lesions of *Neojohnstonia colocasiae* on taro.

**TOP:** Heavily infected taro from Samoa with orange leaf spot (*Neojohnstonia colocasiae*) on an older leaf.

**MIDDLE:** Leaf spots of *Neojohnstonia colocasiae* on taro.

**BOTTOM:** *Neojohnstonia colocasiae* conidiophores are branched, with single spores connected by a short, thin stalk.



# Fungi

## Shot hole

*Phoma* spp.

### What is it?

*Phoma* spp. (*Phoma* sp. and *Phoma colocasiae*) produce relatively large lesions on the leaf. As the spots age, their centres fall out, giving the 'shot hole' effect.

### Where is it found?

*Phoma colocasiae* has been recorded in Palau and Samoa. The Pacific taro fungus, *Phoma* sp., has been recorded in American Samoa, Cook Islands, Federated States of Micronesia, Fiji islands, French Polynesia, Marshall Islands, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga and Vanuatu.

### What does it do?

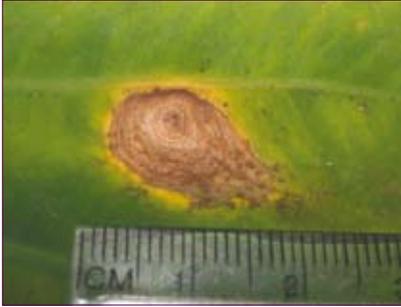
The first symptoms of a *Phoma* infestation are small, round, brown spots on the second or third leaves. As the spots enlarge to 2 cm in diameter, the brown centres fall out, resulting in the typical 'shot hole' symptom. The holes have a narrow, brown margin, which is surrounded by an intense yellow halo. The holes may merge, so that large areas of the leaf are destroyed. This leads to premature leaf death.

### What do I look for?

The leaves are the only part of the plant that show symptoms, so look for the characteristic shot holes. Careful inspection of the leaves and microscopic examination of the pycnidia and spores are necessary. *Phoma* spp. can be mistaken for taro leaf blight (*Phytophthora colocasiae*), particularly when infection levels are high. The difference is that *Phytophthora colocasiae* lesions are often surrounded by a white zone of spores and exude droplets that dry as dark pellets.

### How do I control it?

There is no evidence that the disease warrants control. Fungicides may control the disease; however, they cannot be recommended at present, since recent studies have not established that the disease reduces corm yields.



**TOP:** Close-up of a 'shot hole' lesion caused by *Phoma* sp.

**MIDDLE:** Oval spots caused by *Phoma* sp. are up to 30 mm long, brown with yellow borders, and sometimes merge.

**BOTTOM:** Some of the lesions caused by *Phoma* sp. join together at the leaf margins.

**TOP:** *Phoma* sp. infection on a taro leaf.

**MIDDLE:** The centres of *Phoma* sp. lesions fall out, giving a characteristic 'shot hole' effect.

**BOTTOM:** *Phoma* sp. conidia are cylindrical to oval in shape.



## Fungi

# Taro leaf blight

## *Phytophthora colocasiae*

### What is it?

Taro leaf blight is a major disease of taro. In Pacific island countries, taro leaf blight has prevented farmers from growing taro successfully.

### Where is it found?

*Phytophthora colocasiae* has been recorded in American Samoa, Federated States of Micronesia, Guam, Northern Mariana Islands, Palau, Papua New Guinea, Samoa and Solomon Islands.

### What does it do?

A small, circular speck, brown on the upper surface of the leaf and water-soaked below, is the first sign of the disease. Infections often begin on the lobes and sides of the leaf where water collects. The spots enlarge, become irregular in shape, and are dark brown with yellow margins. Initial spots give rise to secondary infections and, soon afterwards, the leaf blade collapses and dies. Spores are produced at night and can be seen around the spots in the morning. Clear, yellow-to-red droplets ooze from the spots and develop into dark brown, hard pellets as they dry. This is a characteristic of the disease. Spores may be trapped inside the pellets.

Usually, petioles are not attacked, but instead collapse as the leaf blade is destroyed. However, in American Samoa and Samoa, petiole infection is common as the taro varieties are very susceptible to the disease. The fungus can also cause a postharvest corm rot that is difficult to detect unless corms are cut open. The rots are light brown and hard.

### What do I look for?

On the leaves, spots caused by *Phytophthora colocasiae* can be seen with the naked eye. Microscopic examination of the spore masses is required to identify the spores. Corms can carry spores on the surface (undetectable) and mycelium in postharvest rots. Corms need to be cut open to detect the rots.

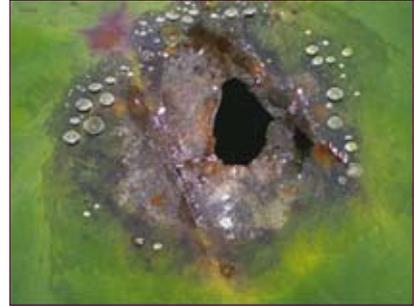
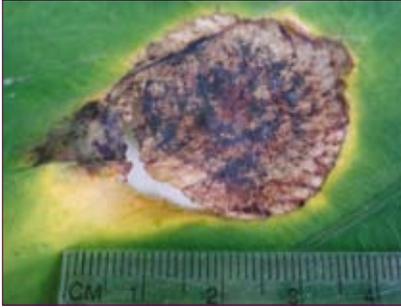
### How do I control it?

**Phytosanitary measures:** Strict quarantine measures must be observed to prevent the spread of the disease to countries where it does not currently occur. Any movement of planting material between countries should be limited to sterile plantlets growing in a tissue culture medium, and they should be indexed for viruses.

**Cultural control and sanitary methods:** Selection of sites away from already infected crops, regular removal of diseased leaves and wide spacings between plants are recommended.

**Chemical control:** Both protectant and systemic fungicides are reported to give control for this fungus. In Samoa, studies done after the outbreak of taro leaf blight recommended phosphoric acid alternated with mancozeb. Corm rots are best controlled by dipping corms in bleach (1% sodium hypochlorite) and storing them in polyethylene bags.

**Resistant varieties:** Varieties with durable resistance to *Phytophthora colocasiae* are known from the Philippines and the Federated States of Micronesia and Palau. These have been used successfully in a breeding program in Samoa. Breeding has also been done in Hawaii and Papua New Guinea. Some of the releases from these breeding programs have been pathogen-indexed and are conserved at the Secretariat of the Pacific Community (SPC) Regional Germplasm Centre, Fiji.



**TOP:** The lesion caused by *Phytophthora colocasiae* is beginning to fall out and the black areas are probably signs of secondary fungal infection.

**MIDDLE & BOTTOM:** Droplets of leaf sap exuded from the margin of the lesion caused by *Phytophthora colocasiae*.

**TOP:** Droplets of leaf sap exude from the margin of the lesion caused by *Phytophthora colocasiae*; this characteristic symptom is seen early in the morning. Later the droplets dry as hard pellets.

**MIDDLE & BOTTOM:** Initial *Phytophthora colocasiae* spots have given rise to secondary infections; gradually, the entire leaf blade is succumbing to the disease.

# Fungi

## Leaf blotch

### *Pseudocercospora colocasiae*

#### What is it?

Leaf blotch is a fungal disease, mostly affecting older leaves. The symptoms are similar to those caused by *Neojohnstonia colocasiae* (orange leaf spot) and *Cladosporium colocasiae* (brown leaf spot).

#### Where is it found?

*Pseudocercospora colocasiae* has been recorded in American Samoa, Fiji, French Polynesia, New Caledonia, Samoa, Solomon Islands and Vanuatu.

#### What does it do?

This fungus has little impact of consequence in taro. It causes blotches with indistinct, circular, yellow-reddish to whitish-green discolouration on the upper surface of the leaf, and black mould growth on the corresponding lower surface. The blotches can be up to 1.5 cm in diameter.

#### What do I look for?

The leaves should be inspected for the presence of leaf blotches as described above. To distinguish between this leaf blotch and leaf spots caused by other fungi (*Neojohnstonia colocasiae* and *Cladosporium colocasiae*), the spores should be inspected under a microscope for identification. Spores can be lifted off the leaf using a scalpel to scrape the surface, or using clear adhesive tape, by pressing a piece gently over the spot and lifting it off the leaf surface. The spores can then be mounted in a drop of water on a microscope slide under a cover slip, and viewed under a compound microscope for identification.

The spore-bearing stalks (conidiophores) are dark, unbranched and arise in bundles from the lesions. The spores are pale olive, club-shaped, with a broadly rounded apex and tapering to an inconspicuous scar, almost smooth, mostly four-celled, and solitary.

#### How do I control it?

This disease is not considered to be of economic importance; therefore, no control measures are necessary. It is a disease of older leaves.



**ABOVE:** *Pseudocercospora colocasiae* causes pale, indistinct, whitish spots on the upper surface of the leaf; on the lower surface, the spots turn light brown as the fungus sporulates.



**ABOVE:** The spore-bearing stalks of *Pseudocercospora colocasiae* are dark, unbranched and arise in bundles from the lesions.

# Fungi

## Corm soft rot

*Pythium* spp.

### What is it?

A number of *Pythium* species have been isolated from the roots and corms of wilted plants in dry and wetland taro.

### Where is it found?

Various *Pythium* species occur throughout the Pacific—see the *TaroPest* CD for species distribution records.

### What does it do?

When infected, the whole plant becomes stunted—the leaf stalks are shortened, the leaf blades become curled or crinkled and, instead of being a deep, healthy green, are yellowish and spotted. The corms show a rot of varying colour from whitish-yellow, through shades of grey and blue, to dark purple. Usually, rot starts at the base of the corm and progresses upward until the whole corm is affected. Occasionally, the disease starts at the side of the corm, 5–7 cm above the base. The skin of a diseased corm becomes softened, usually remaining intact until complete disintegration of the interior of the corm has taken place; then the skin also disintegrates. When the corm is cut open, a sharp line of demarcation can be seen between healthy and diseased tissue.

### What do I look for?

Generally, the rot is evident on the corms as it develops from the base. However, if it is an early infection, lesions on the surface of the corm may be observed—if these are found, the corm should be cut open to see what lies beneath. Although few other species of fungi cause rots in the field, there are others that cause postharvest rots. Therefore, it is necessary to isolate the pathogen and identify it by microscopy.

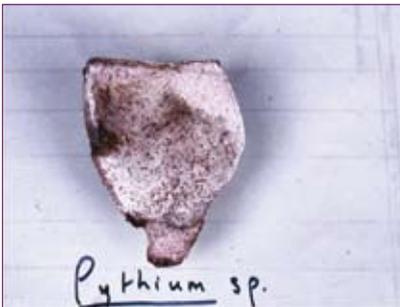
### How do I control it?

**Cultural control and sanitary methods:** Only healthy material that is free from rot should be planted. Removal of diseased plant material from the field at harvest can reduce inoculum levels. Ploughing and drying of wetland taro fields are recommended. Crop rotation with non-host crop plants is also useful. Experiments by taro growers in Halawa (Molokai) gave strong indications that taro rot could be controlled by drying and ploughing the patches, and by applying either lime or coral sand some time before replanting with taro. Calcium has also been implicated in the low incidence of *Pythium* rot on atolls.

**Host plant resistance:** In Samoa, the following varieties have shown resistance: Tusi Tusi, Talo Vale, Pute Mu and Pula Sama Sama. Hawaiian taro varieties Pa'lehua, Maui Lehua, Pa'akala and Paukea are all considered to be resistant to *Pythium* rot.

**Chemical control:** Investigations into preventing postharvest rots caused by *Pythium splendens* (often in a complex with other fungi) in Solomon Islands found bleach (1% sodium hypochlorite) as a corm dip helped to reduce damage. Various fungicides could also reduce rots in early days of storage.

**Traditional practices:** In Solomon Islands, storage in leaf-lined, shallow soil-pits has been shown to reduce damage.



**TOP:** *Pythium* sp.; note the much reduced number of side or feeder roots and the decay of those present.

**MIDDLE:** Root decay and corm soft rot of young taro plants affected by *Pythium* sp.

**BOTTOM:** Taro corm soft rot caused by *Pythium* sp.

**TOP:** Root decay and corm soft rot of young taro plants affected by *Pythium* sp.

**MIDDLE:** Corm soft rot of young taro plants; note the fringe of healthy roots at the top of the corm.

**BOTTOM:** Taro plants showing signs of infection with *Pythium* sp.