



Dasheen Mosaic of Edible and Ornamental Aroids

Scot C. Nelson

Department of Plant and Environmental Protection Sciences

This publication covers dasheen mosaic diseases of *Colocasia*, *Xanthosoma*, and *Philodendron* and discusses some integrated management practices that are useful for its control in severely affected plant species.

Dasheen mosaic is an important and conspicuous viral disease of ornamental and edible aroids throughout the Pacific and worldwide. The pathogen, dasheen mosaic potyvirus (DsMV), was first recorded from dasheen (*Colocasia esculenta* (L.) Schott) in 1970. Today, DsMV is a common and widespread pathogen of the aroids *Aglaonema*, *Caladium*, *Colocasia*, *Dieffenbachia*, *Philodendron*, *Xanthosoma*, and *Zantedeschia*. DsMV is especially threatening to aroid nurseries where plants are grown from cuttings, corms, or bulbs rather than as virus-free materials derived from tissue culture.

Before the advent of tissue-culture technologies, DsMV presented major problems for ornamental species in the Araceae, causing particularly severe reductions in plant growth and yield for species of *Caladium*, *Dieffenbachia*, and *Philodendron*. The use of tissue-cultured, virus-free plantlets helped to reduce or eliminate the dasheen mosaic problem in commercial nurseries. However, the disease can still enter aroid production houses and cause losses, and it can thereafter be spread mechanically by plant sap during further cutting of plants and their vegetative propagation.

Recently, a commercial aroid nursery in Hawai'i reported odd symptoms on a *Philodendron* variety that arrived in Hawai'i from Florida as tissue-cultured plants and thereafter was grown and vegetatively propagated by stem cuttings at the nursery. The grossly distorted foliage of the symptomatic plants tested positive for DsMV, and the entire stock of diseased plants was subsequently destroyed by the grower to prevent further disease spread. This suggests the need for a re-evaluation of the dis-

ease in Hawai'i at this time and a discussion of DsMV transmission and cultural management for ornamental aroids.

Susceptible aroids have a global distribution. The most common host for the virus in Hawai'i, *Colocasia esculenta* (taro, dasheen), is thought to be native to India; it is widely cultivated throughout the tropics for its edible root.

In recent years, new strains of DsMV have been reported for the first time in two genera of orchids. In French Polynesia a severe strain of DsMV attacks some edible aroids including *C. esculenta*, causing severe symptoms from which plants fail to recover or compensate to produce normal yields. In Hawai'i, however, a milder strain of DsMV is widespread among taro plants and appears to cause little reduction of corm yield for most commercial taro types, and it therefore usually warrants no management. However, some taro cultivars in Hawai'i appear to be much more susceptible to DsMV.

The majority of taro plants in Hawai'i are probably infected with DsMV. In a survey by CTAHR's Dr. John Hu and associates in the early 1990s, DsMV was detected in 14 of 15 commercial taro fields, in all 9 commercial taro cultivars surveyed, and in 163 of 186 taro accessions indexed. They developed and used indirect enzyme-linked immunosorbent assay (ELISA) procedures to detect DsMV.

In unpublished research, CTAHR's Dr. Susan Miyasaka and associates established a field planting of DSMV-free taro on the island of Hawai'i in the 1990s. The taro plants were first cleared of DSMV virus infection by tissue culture. After planting, the taro was monitored over time for expression of dasheen mosaic symptoms. Within approximately 3–4 months, virtually all of the taro plants displayed the typical symptoms of the disease, and many of them were expressing the symptoms even

more severely than expected. The presence of a DsMV vector, the green peach aphid (*Myzus persicae*), was confirmed in the taro field (Susan Miyaska, personal communication).

Some speculate or believe that certain Hawaiian taro cultivars are, or were, much more susceptible to dasheen mosaic, and that what remains of the original population of Hawaiian taro varieties is perhaps more tolerant of the disease and those varieties that have become extinct or have been lost from taro collections may have been more intolerant of DsMV infections.

It is commonly reported that DsMV does not cause substantial yield loss to taro, and that is still a prevailing opinion for this taro disease in Hawaii. However, depending on the host-virus strain combination and the location, DsMV can severely impact yields of the edible aroids *Colocasia* and *Xanthosoma* in the Pacific. Symptoms on the more susceptible varieties include chlorotic feathering patterns on leaves and severe leaf curling and malformations.

Hosts

Most of the known hosts of DsMV are among edible and ornamental species of the Araceae (aroids). Worldwide, DsMV infects least 16 genera in this family and is widespread among the edible *Colocasia*, *Xanthosoma*, and *Cyrtosperma* species and among the inedible ornamental genera *Aglaonema*, *Caladium*, *Dieffenbachia*, *Philodendron*, and *Zantedeschia*.

Aroids are plants of the family Araceae; they have small flowers massed on a spadix surrounded by a large spathe. Aroids are widespread globally and very abundant in the tropics. The inedible aroids are important ornamental home and garden plants. The edible aroids are tremendously important to diets of indigenous tropical societies as staple starch-food crops that are capable of withstanding the damaging effects of tidal waves and hurricanes. Taro, perhaps the most widely grown of the edible aroids, is a perennial herb consisting of a cluster of smooth, heart-shaped leaves, rising a foot or higher from underground tubers. In temperate areas it is grown as an ornamental plant for its large, glossy leaves.

In the Orchidaceae, *Vanilla tahitensis* is a host of unique strains of DsMV in French Polynesia and the Cook Islands; a terrestrial orchid, *Spiranthes cernua*, hosts a strain of DsMV in the continental United States. Hosts of DsMV may be grouped on the basis of their symptom expression (Table 1).



At top, leaf malformation and chlorotic feathering along leaf veins are characteristic symptoms of dasheen mosaic disease of taro (*Colocasia esculenta*). Above, close-up of the typical feathering symptom on a taro leaf. (Photos: S. Nelson)



Symptoms of dasheen mosaic on taro (*Colocasia esculenta*): pale whitish to yellow to yellow-green patches on the leaves, characteristically as featherlike patterns along the veins, especially near leaf margins, and leaf deformities. Two or three leaves on a plant may show symptoms, but thereafter normal leaves are produced.

(Photo at left, W. Nishijima, at right, S. Nelson)



Feathering symptoms on the underside of a taro leaf (left) may be associated with reddening or necrosis of small leaf veins. Leaf malformation of taro caused by DsMV infection (right) may consist of wrinkling and puckering of leaf surfaces and leaf margins (Photos: S. Nelson)



Conspicuous necrotic and chlorotic feathering along leaf veins of a dasheen variety (Photo: S. Nelson)

Symptom expression, infection, and disease effects

There may be some overlapping for symptom expression among plant genera; variability in symptom expression may depend on the host, the particular strain of DsMV, and the environment. For example, when severely diseased, *Philodendron* may exhibit vein clearing that resembles chlorotic feathering. Also, symptoms may be intermittent or vary seasonally. For taro, two or three leaves may show symptoms and then apparently healthy leaves are produced, or leaves may alternate between asymptomatic and symptomatic on the same plant.

The pathogen infects leaves, stems, and petioles. The disease results in reduced photosynthesis, reduced corm size or yield, reduction in leaf number or size, deformed leaves, and stunted plants.

Disease cycle for dasheen mosaic

Dispersal: DsMV is dispersed by several species of aphids, by the movement of infected plants; as infected plant sap on pruning tools.

Inoculation: DsMV arrives at the site of infection (a wounded plant cell) in an aphid's mouthparts or on an infested cutting tool.

Infection: DsMV enters a wounded plant cell either by aphid injection or on an infested tool.

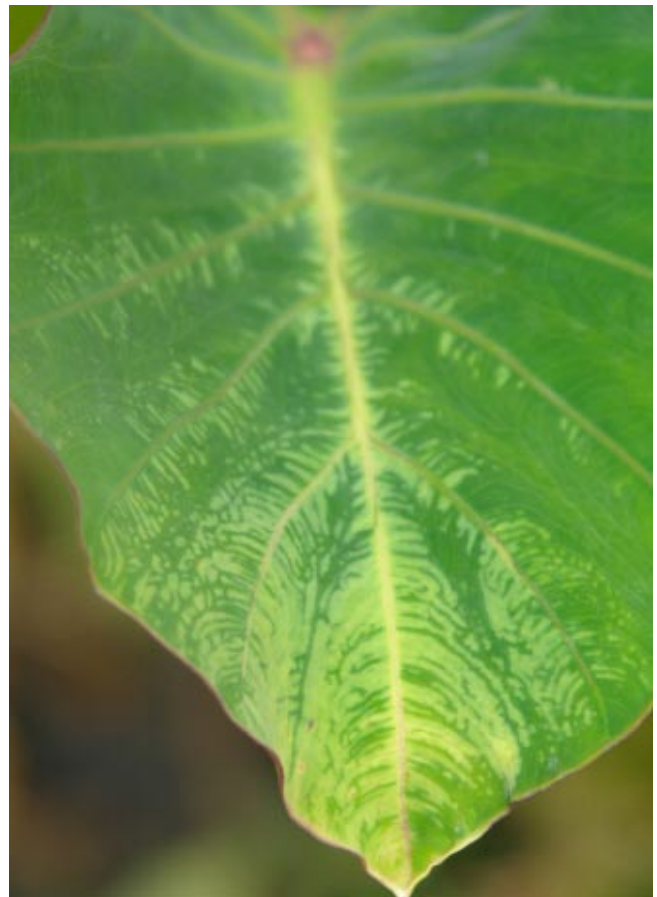
Disease development: Virus particles multiply within plant host cells, eventually resulting in symptom development. Virus particles move between adjacent cells via plasmodesmata and long-distance within a plant via the vascular tissues.

Pathogen reproduction: The virus particles replicate by usurping the plant cell's DNA and protein-synthesizing capacities.

Table 1. General types of disease symptoms caused by DsMV and corresponding plant genera that express the symptoms.

Symptoms	Susceptible genera
Systemic mosaic*	<i>Aglaonema, Alocasia, Amorphophallus, Arisaema, Caladium*</i> , <i>Cyrtosperma</i>
Systemic mosaic, leaf malformation, epinasty, vein clearing, systemic and local necrosis	<i>Cryptocoryne, Dieffenbachia, Philodendron, Richardia, Zantedeschia</i>
Systemic mosaic, leaf malformation, chlorotic feathering along leaf veins	<i>Colocasia, Xanthosoma</i>
Leaf mosaic and malformation	<i>Vanilla tahitensis</i>
Systemic mosaic, chlorotic blotching	<i>Spiranthes cernua</i>

*some cultivars of *Caladium hortulanum* may show feathering along leaf veins.



Mosaic and veinal feathering symptom on both sides of a leaf of a Hawaiian taro variety (Photo: S. Nelson)



DsMV on *Xanthosoma sagittifolium*. Left: white feathering symptoms along the leaf veins of *X. sagittifolium* in Yap. The feathering symptom associated with DsMV is typical of *Colocasia* and *Xanthosoma* species. The the newly emerging leaf (mostly obscured here) is grossly distorted. Right: leaf distortion (puckering) associated with DsMV and the white feathery symptom on *X. sagittifolium* in Yap. (Photos: Craig Elevitch)

Pathogen survival: DsMV survives as viable virus particles within living plant tissues, or for short periods of time in association with the mouthparts of aphid species or as infested sap on tools. DsMV is unable to survive in dead plant tissues or in dead aphids.

DsMV is transmissible by three methods

Vectors: DSMV is transmitted by several species of aphids, including the green peach aphid (*Myzus persicae*), the cowpea aphid (*Aphis craccivora*), and the melon aphid (*Aphis gossypii*). DsMV is not transmitted by the banana aphid (*Pentalonia nigronervosa*) or by the bird cherry-oat aphid (*Rhopalosiphum padi*). The virus is transmitted in a non-persistent manner.

Vegetatively: by suckers, corms, or infected cuttings used for propagation.

Mechanically: by plant sap on knives or shears (yet DsMV is not transmitted by incidental contact or natural rubbing of leaves between plants).

Note: DsMV is not transmitted by seed or by pollen.

Integrated management of dasheen mosaic

Disease management tactics depend upon the crop. For taro in Hawai'i, management of DSMV is generally not warranted on most varieties because the disease apparently has a negligible effect on corm yields. However, symptom expression may be relatively severe on some heirloom Hawaiian taro varieties in some environments.



Symptoms of dasheen mosaic on *Philodendron*: Leaves of *Philodendron* x cv. 'Hope' as a host of DsMV in Hawaii. The test kit shows a positive reaction to potyviruses. The virus was confirmed by ELISA and PCR. Symptoms on this *Philodendron* include mosaic, green islands, deformity, rugosity, epinasty, curling, yellowing and vein clearing. The cultural practices used by the grower included vegetative propagation of this plant by cutting stems with knives or shears. This may have been the means for mechanical transmission of DsMV in this case.

(Photo: Brian Bushe, UH-CTAHR)

Dasheen mosaic can cause major economic losses for ornamental crops such as *Philodendron*; in this case management of the disease is highly recommended due to the damaging effects upon the plant foliage.

IPM (integrated pest management) principles

- Avoid introduction or transmission of the virus during vegetative propagation.
- Prevent the introduction and spread of this disease on new hosts.
- Control aphids and ants where aphid transmission of DsMV is a problem.



Close-up of adult melon aphids (*Aphis gossypii*, adult apterous females, highly magnified) on a kava (*Piper methysticum*) leaf. Colonies of aphids and ants are common on leaves of taro in Hawai'i. Not all aphids found on taro can transmit the virus; for example, banana aphids. (Photo: S. Nelson)



Some variegated aroids do not carry DsMV: Variegated Pothos (*Epipremnum* sp.), showing symptoms of leaf mosaic and perhaps yellow veins, and with leaf deformity and rugosity due to feeding injury by aroid thrips. These symptoms should not be confused with DsMV on other aroid hosts. The mosaic symptom is due to genetic variegation, not to disease. (Photo: S. Nelson)

IPM tactics

- Take cuttings or vegetative sprouts from virus-free plants only.
- Prevent mechanical transmission of the virus on knives and shears (dip knives in sterilizing solution between cuts).
- Use certified plants from tissue culture.
- Plant quarantine: intercept diseased plants at point of entry.
- Nurseries should inspect plants upon arrival and before shipping to prevent the spread of plant diseases in Hawai'i.
- Avoid intercropping taro with other susceptible aroids.
- Avoid using the same knives or blades that are used to harvest taro leaves for vegetative propagation of other susceptible aroids.
- Avoid growing taro in nurseries alongside other susceptible aroids.
- Propagate from seed (DsMV is not seed-transmissible).
- Culture plants from shoot tips.
- Control the aphid vectors where the disease is causing losses.

To detect the disease, visually inspect all leaves of plants for white feathering symptoms (*Colocasia*, *Xanthosoma*, and some cultivars of *Caladium hortulanum* such as 'Candidum,' 'Candidum Junior', and 'White Christmas') or mosaics and leaf deformation (*Philodendron*, *Dieffenbachia*, *Spathiphyllum*, and *Zantedeschia*, for example). Ornamental greenhouse-grown aroids may express symptoms intermittently or even be asymptomatic.

When a symptomatic aroid is submitted to the CTAHR Agricultural Diagnostic Service Center for virus detection, the test consists of one or more of the following:

- ELISA (enzyme-linked immunosorbent assay) for potyvirus
- PCR (polymerase chain reaction) or DsMV-specific ELISA test.

Diagnostically susceptible host species and symptoms

Philodendron selloum: systemic mosaic, vein clearing, malformation.

Caladium hortulanum, *Colocasia* spp., *Xanthosoma* spp.: systemic mosaic.

Dieffenbachia spp.: systemic mosaic, epinasty, systemic and local necrosis.

Philodendron verrucosum: local necrosis; not systemic.

Zantedeschia spp.: systemic mosaic, malformation.

Notes

Taro is also susceptible to at least two other plant-pathogenic viruses not yet in Hawai'i, *Colocasia* bobone disease rhabdovirus (cause of bobone disease) and dasheen bacilliform badnavirus (cause of alomae disease). The symptoms are somewhat similar in appearance to dasheen mosaic, yet more severe mosaic, leaf malformation and curling occurs with much more severe effects upon plant growth.

References

- Elliot, M.S., F.W. Zettler, and L.G. Brown. Dasheen mosaic potyvirus of edible and ornamental aroids. University of Florida, Plant Pathology Circular no. 384.
- Plant Viruses Online. <http://image.fs.uidaho.edu/video/descr289.htm>.
- Farreyrol, K., M.N. Pearson, M. Grisoni, D. Cohen, and D. Beck. 2006. Vanilla mosaic virus isolates from French Polynesia and the Cook Islands are Dasheen mosaic virus strains that exclusively infect vanilla. *Archives of Virology* 151:905–919.
- Jordan, R., M.A. Guaranga, G. Kinard, and S. Lynn. Detection and first report of dasheen mosaic virus and a second potyvirus infecting the terrestrial orchid *Spiranthes cernua*. *Acta Horticulturae* (ISHS) 568:253–260.
- Hu, J.S., M. Wang, R. Reolanei, and S. Meleisea. 1994. Detection of dasheen mosaic virus from taro plants in the field and in tissue culture. *Plant Disease* 78:754.
- Hu, J.S., S. Meleisea, M. Wang, M.A. Shaarawy, and F.W. Zettler. 1995. Dasheen mosaic potyvirus in Hawaiian taro. *Austral. Plant Pathol.* 24:112–117.
- Kohler, F., F. Pellegrin, G. Jackson, and E. McKenzie. 1997. Disease of cultivated crops in Pacific island countries. South Pacific Commission, Noumea, New

Caledonia.

- Liu, L.J.Y., E. Rosa-Marquez, M. Licha, and M.L. Biascoechea. 1988. Tanier (*Xanthosoma* spp.) propagation in vitro. *Journal of Agriculture of the University of Puerto Rico*. 72:413-426.
- Neal, M.C. 1965. *In gardens of Hawaii*. Bishop Museum Press, Honolulu.
- Wagner, W.L., D.R. Herbst, and S.H. Sohnmer. 1990. *Manual of the flowering plants of Hawaii*. Bishop Museum Press, Honolulu.
- Zettler, F.W., and R.D. Hartman. 1987. Dasheen mosaic potyvirus as a pathogen of cultivated aroids and control of the virus by tissue culture. *Plant Disease* 71:958–963.

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