CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

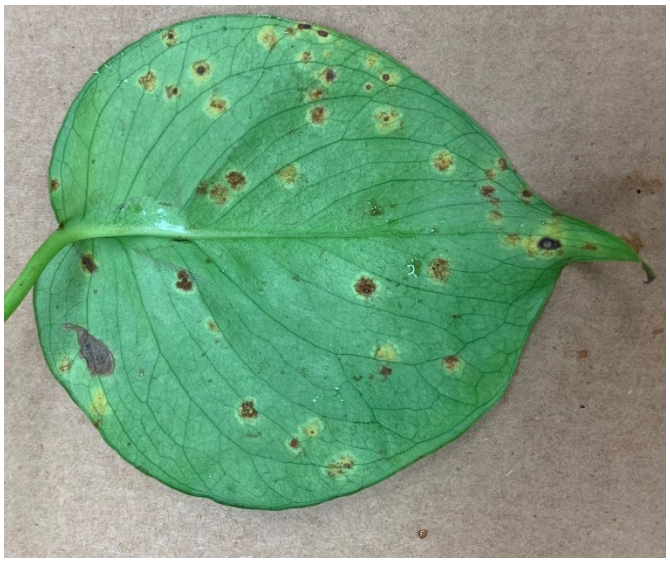
Puccinia paullula (Sydow and Sydow 1913)

Monstera Rust

Current Pest Rating: Q

Proposed Pest Rating: A

Kingdom: Fungi; Division: Basidiomycota
Class: Pucciniomycetes; Order: Pucciniales
Family: Pucciniaceae



***Puccinia paullula* pustules on the underside *Monstera* spp. leaf**

Photo credit: Cheryl Blomquist, CDFA

Comment Period: 11/08/2022 through 12/23/2022

Initiating Event:

On August 16, 2022, inspectors from the San Mateo County Agricultural Commissioner's office collected leaves from an incoming nursery shipment of 25 *Monstera spp.* plants grown in Palm Beach

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County, Florida. The leaves were sent to CDFA's Plant Pest Diagnostics Center at Meadowview. CDFA Plant Pathologist Cheryl Blomquist identified the rust pathogen *Puccinia paullula* by morphology and sequence analysis from the leaf samples. This was a first official detection of this fungus in the Americas, however, there is a published report from 2019 of *P. paullula* detected on *Philodendron* sp. in Broward County, Florida (Urbina, 2019). It was assigned a temporary Q rating. The risk to California from *Puccinia paullula* is described herein and a permanent rating is proposed.

History & Status:

Background:

The Araceae are a family of monocotyledonous flowering plants in which flowers are borne on an inflorescence called a spadix. The spadix is usually partially enclosed in a spathe or leaf-like bract. Also known as the arum family, members are often colloquially known as "aroids". Many species display very decorative leaves and flowers, and they are widely used as indoor plants in temperate climates and as outdoor plants in the tropics.

Monstera is a genus of approximately 50 species of flowering plants in the family Araceae that are native to tropical regions of the Americas. They are evergreen vines, growing to heights of 20 meters in trees, climbing by means of aerial roots that hook over branches. Their roots will also grow into the soil to help support the plant. Since they can send roots both into the soil and over trees, they are classified as hemi epiphytes. The best-known member of the genus, *Monstera deliciosa*, is also cultivated for its edible fruit (Duarte and Paull, 2015). *Monstera deliciosa* has the common name of "Swiss cheese plant". It is also called "split leaf philodendron", but this is no longer taxonomically, *Philodendron* is a separate genus from *Monstera* in Araceae. *Monstera deliciosa* is native to the wet forests of southern Mexico, Guatemala, and parts of Costa Rica and Panama (Duarte and Paull, 2015). It has been spread by horticulture trade and is now pantropical. It has naturalized in many areas, for instance in Florida and coastal areas of Australia. It is considered mildly invasive in Hawaii (Stone et al., 1992).

Rust fungi are obligate parasites that must have a living host to parasitize. *Puccinia* spp. can have complex lifecycles involving up to five types of spores produced annually and sequentially. The five types of spores are: stage 0: spermogonia-bearing spermatia, stage I: aecia-bearing aeciospores, stage II: uredinia-bearing urediniospores, stage III: telia-bearing teliospores, and stage IV: basidia-bearing basidiospores. All five spore types of a given species can occur on a single host (i.e., rose rust); alternatively, the different spore types of a species can colonize two very disparate hosts in a strict, alternating sequence (i.e., cedar-apple rust). Many of the rusts important to agronomic crops have evolved much simpler life cycles, with everything on a single host with fewer than five spore stages. These are called microcyclic rusts. Some have only uredinia (i.e., hollyhock rust), or telia plus basidia (i.e., chrysanthemum white rust) (Agrios, 2005).

Monstera rust is a microcyclic rust without a known alternate host which has two spore stages, urediniospores and teliospores. Signs on *Monstera* spp. include orange, erumpent rust pustules

primarily on the leaves. These pustules produce thousands of powdery urediniospores. Urediniospores can autoinfect the same plant or move short or long distances with air currents to other susceptible plants. Under favorable environmental conditions, multiple cycles of infection, sporulation, and re-infection can produce very destructive epidemics within a few weeks. Over time, pustules convert from producing only urediniospores to producing urediniospores and teliospores.

Hosts: Alocasia sp. (elephant's ear), *Amorphophallus campanulatus* (elephant foot yam), *Monstera deliciosa* (Swiss cheese plant), *Monstera* sp. (Farr and Rossman, 2022).

Symptoms: Symptoms are first observed on the leaf surfaces as small chlorotic spots, which expand and become brown to reddish-brown, and produce pustules with uredinia with abundant urediniospores. Brown colored powdery pustules, up to 5 mm in diameter, can occur on both leaf surfaces of mature leaves. Urediniospores are present throughout the year but with low germination except during the cooler months. Teliospores were produced only during the warmer months from inside the same pustules. Teliospores germinated without dormancy but were unable to infect *M. deliciosa* and their role in pathogenicity is uncertain (Shaw, 1991). Infection may cause leaf distortion and severe defoliation. The fungus destroys the leaf tissue, reducing the plant's photosynthetic capacity. This often results in poor shoot growth, reduced flowering, and leaf dieback.

Transmission: Rust fungi release millions of spores from pustules which are rapidly transported long distances by wind. The disease also spreads with infected nursery stock, contaminated clothing, infested equipment, and by insects and on animals as contaminants. Rust spores are not borne internally in seed but can be carried on the outside of seeds.

Damage Potential: Rust pathogens generally do not kill their hosts. The growth and reproduction of the fungus diverts nutrients from the plant tissues that would otherwise be used for vegetative growth and seed development. Pustules breaking through the epidermal tissue make it difficult for plants to control transpiration, leading to desiccation. The presence of pustules dramatically detracts from the esthetic value of ornamental plants. Secondary infection by other pathogens after rust infection can occur. Shaw (1995) reported infection by *Colletotrichum gloeosporioides* through lesions of *Puccinia paullula* on *Monstera deliciosa.*

Monstera is a perennial plant that is propagated vegetatively. *Monstera deliciosa* and *M. adansonii* are cultivated on Hachijo Island, Japan. *Puccinia paullula* was first found there in February 2021, and within a year, the disease found across the island with symptom incidence ranging from 5 to 30% (Sakamoto et al., 2022).

Worldwide Distribution: Australia, Malaysia, New Caledonia, Papua New Guinea, Philippines (Farr and Rossman, 2022), United States (Florida) (Urbina, 2019), and it has recently been reported in Japan (Sakamoto et al., 2022).

Official Control: None

California Distribution: None

California Interceptions: There has been one interception with an incoming nursery shipment from Florida (see "initiating events") and the plants were rejected.

The risk *Puccinia paullula* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** *Monstera* spp. are important indoor plants and are used outdoors as an ornamental in some wet tropical and subtropical areas. Spores require free water for germination. Lack of moisture could be a limiting factor in the development of epidemics in California, but the pathogen is likely to survive wherever the hosts can be grown. Epidemics can occur under warm, humid greenhouse conditions.

   Evaluate if the pest would have suitable hosts and climate to establish in California.

   Score: **2**

   - Low (1) Not likely to establish in California; or likely to establish in very limited areas.
   - **Medium (2) may be able to establish in a larger but limited part of California.**
   - High (3) likely to establish a widespread distribution in California.

2) **Known Pest Host Range:** The host range is limited to one family, infecting several genera within that family.

   Evaluate the host range of the pest.

   Score: 1

   - **Low (1) has a very limited host range**.
   - Medium (2) has a moderate host range.
   - High (3) has a wide host range.

3) **Pest Reproductive Potential:** *Puccinia* spp. can produce explosive epidemics on susceptible hosts. Urediniospores are generated in extremely large numbers and repeating cycles of secondary infection allow for exponential increase of disease. Spores are wind-borne.

   Evaluate the natural and artificial dispersal potential of the pest.

   Score: 3

   - Low (1) does not have high reproductive or dispersal potential.
   - Medium (2) has either high reproductive or dispersal potential.
   - **High (3) has both high reproduction and dispersal potential.**

4) **Economic Impact:** Ornamental foliage plants have a low or zero tolerance for any pathogens that damage the leaves. This rust causes very large and noticeable pustules on leaves. Rust infection also increases infection from other foliar pathogens such as *Colletotrichum sp*.

Evaluate the economic impact of the pest to California using the criteria below.

Economic Impact: A, B

A. The pest could lower crop yield.
B. The pest could lower crop value (includes increasing crop production costs).
C. The pest could trigger the loss of markets (includes quarantines).
D. The pest could negatively change normal cultural practices.
E. The pest can vector, or is vectored, by another pestiferous organism.
F. The organism is injurious or poisonous to agriculturally important animals.
G. The organism can interfere with the delivery or supply of water for agricultural uses.

Economic Impact Score: **2**
- Low (1) causes 0 or 1 of these impacts.
- Medium (2) causes 2 of these impacts.
- High (3) causes 3 or more of these impacts.

5) Environmental Impact: This rust could impact indoor and outdoor ornamental plants, especially in nursery production stages.

Evaluate the environmental impact of the pest to California using the criteria below

Environmental Impact: E

A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.
B. The pest could directly affect threatened or endangered species.
C. The pest could impact threatened or endangered species by disrupting critical habitats.
D. The pest could trigger additional official or private treatment programs.
E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.

Environmental Impact Score: 2
- Low (1) causes none of the above to occur.
- Medium (2) causes one of the above to occur.
- High (3) causes two or more of the above to occur.

Consequences of Introduction to California for *Puccinia paullula:* Medium

Add up the total score and include it here**. 10**
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

6) **Post Entry Distribution and Survey Information**: Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication, or have been delimited with no further detections should not be included.

   Evaluation is 'not established'.

   Score: 0

   -Not established (0) Pest never detected in California or known only from incursions.

   -Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).

   -Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.

   -High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.

7) **The final score is** the consequences of introduction score minus the post entry distribution and survey information score: (Score)

   Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 10***

Uncertainty:

This pathogen moves with infected nursery stock. With a 2019 detection in Broward County reported by Urbina, and the San Mateo County's interception on nursery stock from Palm Beach County, Florida, there is reason to worry that the pathogen may already be in the national nursery trades. There are other species of rusts which infect aroids, and identifications should be made only by qualified diagnosticians.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Puccinia paullula* is A.

References:

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Duarte, O.; Paull, R., 2015. Exotic fruits and nuts of the New World., Exotic fruits and nuts of the New World: ix + 332 pp. http://www.cabi.org/cabebooks/ebook/20153017861

Farr, D.F., and Rossman, A.Y. 2022. Fungal Databases, U.S. National Fungus Collections, ARS, USDA. Retrieved September 27, 2022, from https://nt.ars-grin.gov/fungaldatabases/

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Shaw, D.E., 1991. Rust of *Monstera deliciosa* in Australia. Mycological Research, 95(6), pp.665-678.

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Stone, C.P., Smith, C.W. and Tunison, J.T. eds., 1992. Alien plant invasions in native ecosystems of Hawai'i: Management and research (p. 887). Honolulu: University of Hawaii.

Urbina, H. 2019. Plant Pathology. P.J. Anderson and G.S. Hodges (Editors). TRI-OLOGY Volume (58): page 17-18. Accessed 9/26/2022 https://www.fdacs.gov/ezs3download/download/91262/2587845/Media/Files/Plant-Industry-Files/Tri-ology-58-4-Oct-Dec2019.pdf

Responsible Party:

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*Comment Period: 11/08/2022 through 12/23/2022

*NOTE:

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at permits[@]cdfa.ca.gov.

Comment Format:

- Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

  Example Comment:

Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to "Climate/Host Interaction" here.]

- Posted comments will not be able to be viewed immediately.
- Comments may not be posted if they:

  Contain inappropriate language which is not germane to the pest rating proposal;

  Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;

  Violates agency regulations prohibiting sexual harassment or other forms of discrimination;

  Violates agency regulations prohibiting workplace violence, including threats.

- Comments may be edited prior to posting to ensure they are entirely germane.
- Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.

Proposed Pest Rating: A
