Creating a Sanctuary for the Conservation of *Amorphophallus titanum* and Related Species

Mohammad Mehdi Fayyaz, Ph.D.
Director of Botany Greenhouses and Garden
University of Wisconsin-Madison

Bryan Brunner Fulton, Ph.D.
Researcher and Head
Horticulture Department
University of Puerto Rico
Mayaguez Campus

Introduction and Justification

In Sumatra, Titan Arum- ***Amorphophallus titanum*** - grow on fertile, well-drained, hill slopes adjacent to rivers and streams. The plant is sometimes found in secondary forest and at the edge of farmland. No one knows how common the titan arum is in the wild, though most experts suspect it is endangered. Although Indonesia occupies only 1.3% of the world's land area, it possesses 10% of the world's flowering plant species, 12% of all mammal species, 17% of all reptile and amphibian species and 17% of all bird species. Indonesia's rainforests provide habitats for species such as the orangutan, Sumatran tiger and Asian elephant; as well as a home for millions of people.

Tragically in Sumatra the habitat of this wonder of the plant kingdom- ***Amorphophallus titanum*** -is being threatened to the point of nearly extinction of this species. Scientists estimate that the forest habitat of the Titan Arum is likely to vanish from Sumatra by the year 2005. The rare plant's existence in the wild is threatened by several factors, including unrestrained illegal logging, forest over-exploitation, harvesting of its tubers and the disappearance of animals such as the rhinoceros hornbill bird (***Beceros rhinoceros***) which help spread its seeds.

Indonesia has now lost 72% of its original rainforest cover and some two million hectares of rainforests continue to be deforested a year - an area larger than the state of Connecticut. Illegal logging, conversion of forest to agricultural land, forest fires and population growth are causing deforestation on an unprecedented scale and may cause the nation's forests to disappear by 2010. Massive illegal logging operations even threaten national parks such as the Leuser Ecosystem in northern Sumatra, home of the world's largest natural orangutan population. Indonesia's illegal logging industry is estimated to be worth around US$5 billion per year. Most of the timber winds up in China, Europe, and the United States.

Since this amazing biodiversity and ecological complexity are severely threatened to the point of Titan Arum extinction, we propose creation of a sanctuary to cultivate this species in another, similar but safe habitat to insure future preservation of this species. Creation of a sanctuary for this plant and related species represents an excellent and unprecedented opportunity for sophisticated collectors of rare plants, botanists, and horticulturists, in this country and elsewhere to work together with professional conservationists to preserve the species.

Public awareness, along with horticultural, ecological studies and protection of the ***Amorphophallus titanum*** will insure our objectives.

History

Amorphophallus titanum is native to the equatorial rainforests of central Sumatra in Indonesia, where the species was discovered by Italian botanist Odoardo Beccari in 1878. Dr. Beccari sent seeds to the Kew Royal Botanic Gardens in England, where the first cultivated *Amorphophallus titanum* bloom occurred in 1889. A Titan Arum bloomed for the first time in the United States at the New York Botanical Garden in 1937, and the first bloom in the State of Wisconsin occurred in June of 2001.

The University of Wisconsin–Madison's Titan Arum was grown from seed collected in Sumatra in 1993, by the late James Symon, who generously dispensed seeds to a number of U.S. botanists, including Mark Dimmitt in Arizona. He in turn gave a two-year-old seedling to UW–Botany researcher Dr. Tom Gibson. Under the care and supervision of UW-Botany Greenhouses and Garden Director Dr. Mohammad Mehdi Fayyaz, this plant has thrived on campus since 1995, enjoying temporary lodgings in the UW Walnut Street Research Greenhouses until settling into its permanent home in the Botany Greenhouse. There, at the tender age of 7.5 years, it bloomed.

Botanical Description

Amorphophallus titanum is a member of the Family Araceae, the Aroids or Arum plants. Other members of this family include Calla Lilies, Anthuriums, Dieffenbachia, and Philodendrons. All these genera are part of University of Wisconsin Botany Greenhouses teaching collections.

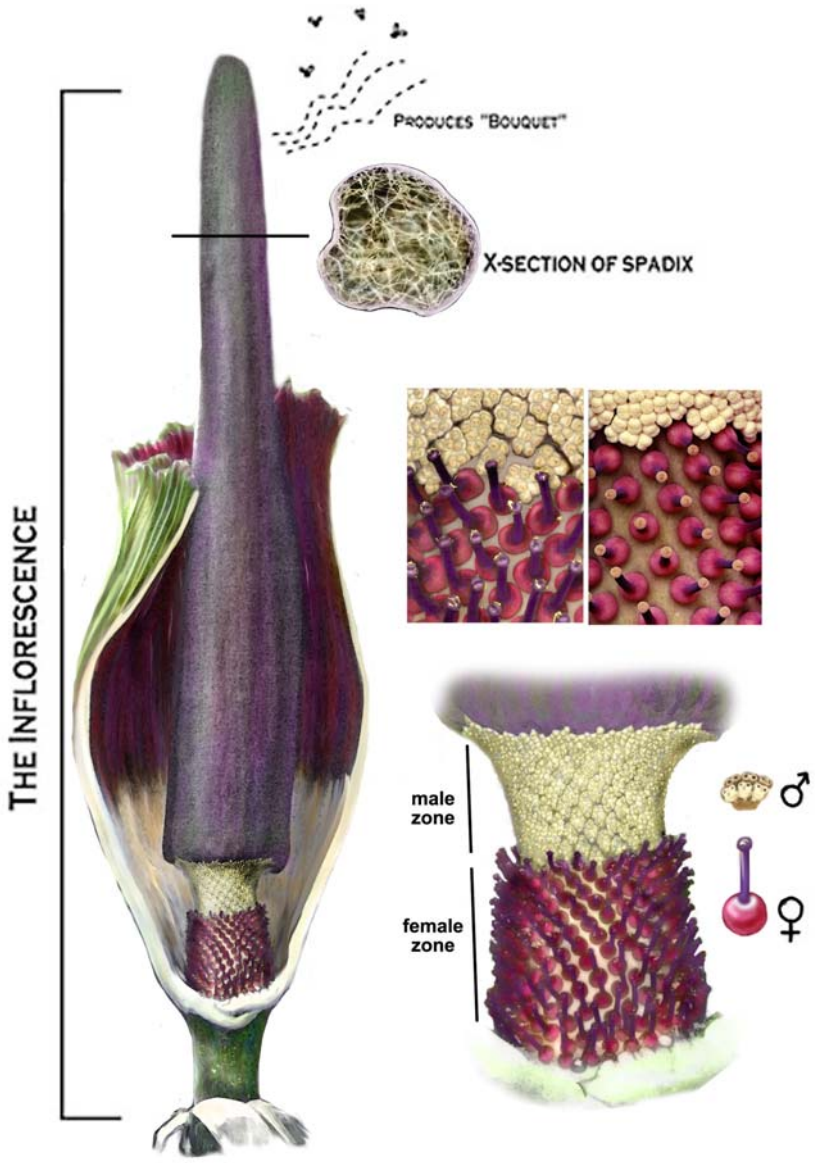
This acaulescent, herbaceous perennial plant grows from a large tuber that can weigh over 170 pounds with a diameter of up to 25 inches. A single, huge umbrella-like leaf originates from the tuber. The leaf consists of a vertical smooth, dark-green petiole with light-green speckles, and a highly dissected lamina (the individual leaflets are elongate elliptic, up to 16 inches long, acuminte and rather leathery). In cultivation the petiole can grow over 12 feet tall and in the wild can reach 20 feet. The dissected lamina may stretch 15 feet wide. During this vegetative stage an entirely new tuber is being formed, which under optimal environmental conditions may be two to three times the weight of the previous tuber. An individual leaf may live for over a year before senescing. The tuber then enters a short dormant period before producing either another leaf, or very rarely an inflorescence (never both at the same time).

In the UW–Botany greenhouses, the Titan Arum's tuber reached a diameter of over 22 inches and a circumference over 75 inches. The petiole and the dissected lamina (of the year previous to the bloom) grew over 10 feet tall and 8 feet wide, respectively.

Amorphophallus titanum has the largest non-branched inflorescence (cluster of male and female flowers) among flowering plants. This titan inflorescence consists of:

• A **peduncle** that can reach over 30 inches tall.
• A **spadix** (fleshy central column), which may reach over 10 feet tall and, at its base, produce a cylindrical female zone over 20 inches high, and an obconical male zone up to 14 inches high.
• A **spathe** that is vast, leafy, ribbed, lobate and plicate or frilly-edged, trumpet-shaped structure, bright yellow-green on the outside and deep maroon inside, enclosing the spadix . Only when the flowers are fully mature does the spathe undergo its sudden-onset, short-lived (two days) unfurling.

The spathe unfurls about 3 to 5 weeks after the bud tip first appears. The flower typically stays open for two and occasionally three days. The Titan Arum heats up during its bloom. The fully open inflorescence emits a carrion bouquet, hence its Indonesian common name of Corpse Flower. Why do the Titans do this? The wonderful smell that these corpse flowers are famous for is composed primarily of fairly heavy, sulfur-based compounds that do not become airborne easily. The plant heats itself up in order to volatilize its "perfume," enabling the smell to go further, attract more flies, and increase the chance of pollination. To heat up, the plant "burns" stored carbohydrates, short-circuiting its basic respiratory process in order to maximize the production of heat. Many members of the Arum family perform metabolic burns like this, albeit on a smaller scale. Unfortunately, the enormous amount of energy the plant expends in attracting flies limits the amount of time it can bloom, which explains why these plants typically bloom for only a few days, and why they don't bloom every year.
The odor, strongest at night, attracts pollinators that in its Sumatran home are thought to be carrion beetles, dung beetles and sweat bees. Collapse of the spadix takes place three or five days after pollination.



Over a thousand unisexual flowers without perianth are hidden inside the base of the spadix.

A male flower consists of 3 to 7 stamens, with 1/12 inch long, truncate anthers possessing two apical, elongate pores. Pollen is inaperturate and with a smooth exine.

A female flower consists of a two-ovule, maroon, conical or ovate ovary, about 1/4 inch in diameter; a robust, dark purple style that's whitish at the base; and a deep purple, depressed globose stigma about 1/8 inch in diameter.

The female flowers are receptive on the first day of full bloom, the male flowers releasing pollen the next day, precluding self-pollination. After fertilization, the peduncle continues to grow. The infructescence may be more than 20 inches long, carrying several hundreds of berries. The fruits turn a bright orange-red to fiery red as mature, and are attractive to birds, the assumed primary seed dispersal agents. Fruits are typically 1.5 inch long, 3 inches in circumference, and usually contain two seeds.

On April 27, 2001, our Titan Arum's bud emerged from the soil and proceeded to grow 4 to 6 inches per day. The spathe opened on June 7, 2001; the next day the spadix peaked at 8 feet 5 inches tall. On June 28, the female zone of the spadix spanned 8 inches vertically and the male zones 4 inches. The peduncle was 14.5 inches.

Pollen had been received a day earlier from a Titan Arum that bloomed on June 3-4 at the Marie Selby Botanical Gardens in Sarasota, Florida. This donor pollen was applied by hand and insect (green-bottle flies) to the female flowers during the evening, after which the spathe closed for the night. It partially opened the next day, but never fully extended

again. (Tenting for several hours in plastic for gas analysis and other alterations of the microenvironment may have negatively affected the blooming sequence.)

POLLINATION OF A RARE FLOWER

On June 28, each of the approximately 1000 berries measured 3/4 inches in both length and width.

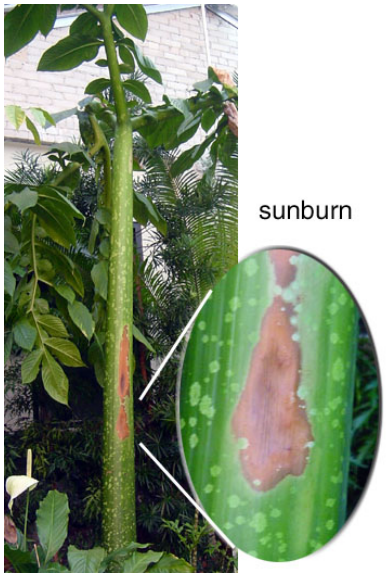
Withering of the spire-like spadix occurred gradually, starting at the tip on June 10, three days after pollination. The structure entirely collapsed on June 12. The spathe had noticeably wilted by June 11, slowly peeled away from the flowers, and on June 22 fell off to expose the maturing fruits and seeds.

On October 12, 2001, growth of the infructesence had ceased and fruits had begun to turn bright red, staring from the top of the female zone. The largest fruit measured 1.5 inches long and 3 inches in circumference.

Cultivation

Light

Ideal is a partial shade, diffused or filtered sunlight. We keep our *A. titanum* in a "High House" that serves as a conservatory. To reduce temperature and light intensity, and to prevent sunburn to the tropical plants during spring and summer months, we paint the greenhouse glazing with whitewash in March; this shading is removed in September.



Humidity

Our plants are kept mostly above 70% humidity.

Soil

It is best to use rich loamy soil, such as a mix consisting of decayed cow manure, peat moss and silica sand. We used a different mix for each of the two *A. titanum* plants in our collection, and both plants are doing well. The mix used for the individual that flowered contains 3/12 parts well-decomposed cow manure, 4/12 silica sand, and 5/12 Stronglite (highly decomposed pine bark mix). The alternate mix contains 3 parts Fafard growing mix #2 (70% Canadian peat mosses 30% perlite and vermiculite), 1-1/2 parts soil and 1/2 part Turface.

Fertilizer

Titan arum grows best in a nutrient-rich medium. Addition of fertilizer especially high in Phosphate is beneficial to tuber development. We used Peter's 20-20-20 fertilizer in our monthly fertilizer applications.

Temperature

Titan arum prefers 65-70°F at night and 75-85°F during daytime. Since we do not have a cooling system in our greenhouse, there were days when temperatures were above 85°F, with adverse effect on the plant.

Water

We use only rain or distilled water. During active plant growth, the medium is kept moist but not wet. This species becomes subject to rot if it's kept too wet. To avoid this, we added silica sand or perlite to our soil mixes.

Rest Period

If the tuber had grown a leaf only:

When the plant enters its rest period (dormancy), the petiole becomes yellow and its tissues soften; at this time it should be cut off some 4-5 inches above the tuber. If your pot is large enough, you may leave the tuber in the pot. During this rest period little or no water is given, and temperature is reduced accordingly. If repotting is necessary, lift the

tuber from the medium, wash it, and inspect it for soft spots. Soft spots should be cut out deeply – all the way to healthy tissue – and scared tissues should be treated with fungicide. After drying the tuber, place it on a soft substrate to prevent further damage to the tuber from its own weight, and keep it in a humid and warm place.

A new shoot will emerge in 3-6 months. At this time the tuber should be potted up in a new container twice as big than the previous one. Using one of the recommended soil mixes, plant the tuber half way down the height of the pot.

If the tuber had previously flowered:

After flowering and harvesting the fruits, we recommend cutting back the peduncle and leaving the tuber in its pot. Reports indicate that most cultivated *A. titanum* die after flowering due to nutrient exhaustion. Any lifting and repotting will increase the risk of damage to the tuber and adversely affect the plant's ability to grow again.

Propagation

Sexual

Seed

After harvesting the fruits, remove pulp and sow seeds in a 4-inch clay pot on top of a medium made of 80% regular soil, 10% sand and 10% pumice. Cover the seeds with a thin layer of sand. Experience has shown that seeds not covered with sand did not germinate.

Another successful method is to sow seeds in pro-mix in a tray with high humidity and 80-85°F.

Vegetative

Division

New shoots may arise from accessory buds on the tuber, with each shoot yielding a new tuber.

Cuttings

To make a cutting from *Amorphophallus*, select a leaf that is mature (not newly emerged, but not yet getting old).Go up the petiole to where it is 3-parted, then farther on to where it is 2-parted. Right where it branches into 2 divisions is where you should cut. Take 2 cuttings from there and 2 from each of the remaining divisions, for a total of 6 cuttings. Do not take more than this, or you could affect the plant's health. Cuttings should be about 8-12 inches long.
The bottom 3 inches of the cutting should be free of leafy material except for the "vein", so trim this area – it will look like a stick on those 3 inches. Dip in rooting hormone and place the bottom 3 inches into soil – a good rooting

mix like peat and perlite. For the portion of the cutting that remains above the soil, trim to 5-7 inches, cutting heavy leaflets off or at least in half. Place in a warm humid area and wait at least 8 weeks for a new tuber to form.

Titan Arum Conservation Sanctuary

In order to insure the future preservation of *Amorphophallus titanum*, we propose the establishment of a breeding population for horticultural and botanical study, as well as for propagation and distribution of this endangered species, in a habitat similar to the plant's native ecosystem. To achieve this goal, a total of 52 seedling Titan Arum plants will be planted in the field in Spring, 2003, at Montoso Gardens, a farm owned by Dr. Brunner. Montoso Gardens is a 90 acre farm and botanical garden, with over 600 species of tropical fruits, gingers, heliconias, palms, cycads, and other tropical plants.

The proposed area for establishment of the Titan Arum Sanctuary is very appropriate for culture of *Amorphophallus* species; currently *A. rivieri* and *A. paeoniifolius* are being successfully grown there. The site is located at an elevation of 1,500 feet, and is a southwest slope with a well drained clay soil (pH 4.5 to 5.5). Rainfall is about 100 inches per year, with a dry season from January through March, which coincides with the *Amorphophallus* dormancy period. Planting distance will be 15 feet between plants.

***Amorphophallus paeoniifolius* flowering at Montoso Gardens.**

Site preparation, planting and regular horticultural maintenance will be provided without cost to the project by Montoso Gardens. Titan Arum plants will be provided without cost to the project by the University of Wisconsin Botany Department Greenhouses and Garden. Visits for observation, photography or scientific study by botanists, horticulturists, students and other interested persons will be encouraged, especially during flowering periods, but must be coordinated through Dr. Brunner. Any seed produced will be divided equally between Montoso Gardens and the University of Wisconsin Botany Department Greenhouses and Garden.

We are requesting travel expenses (University of Wisconsin) for Dr. Fayyaz to visit Puerto Rico and participate in the establishment of the Titan Arum Conservation Sanctuary planting. While in Puerto Rico, we are requesting lodging for Dr. Fayyaz at the Hotel Colegial, and meals at the RUM Cafeteria. Local transportation for Dr. Fayyaz will be provided by Dr. Brunner at no cost to the project.

We feel that this cooperative project will be of benefit to both the University of Wisconsin and the University of Puerto Rico by providing a unique, low cost opportunity for conservation, study and propagation of the endangered *Amorphophallus titanum* in an ecological environment similar to its native habitat.

References

1. Hetterscheid, W.L.A. & S. Ittenbach (1996)): Everything you always wanted to know about *Amorphophallus*, but were afraid to stick your nose into! Aroideana 19: 7-131.
2. http://www.huntington.org/BotanicalDiv/TitanArum.htm
3. http://www.selby.org/research/titanum/facts.htm
4. Upton, Kathy K. Biology Department, University of Missouri, St. Louis. Missouri. Upton@umsl.edu

A second Titan Arum bloomed at the University of Wisconsin-Madison Botany Greenhouse on Wednesday, July 31st, 2002.

Graphics prepared by UW-Botany Multimedia staff artist Kandis Elliot.