Propagation of *Amorphophallus* by Leaf Petiole Cuttings

Tony Avent
Juniper Level Botanic Garden
@ Plant Delights Nursery Inc.
9241 Sauls Road
Raleigh, NC 27603
919.772.4794
January 29, 2007

ABSTRACT

It is our hope to expand the available information with regards to amorphophallus propagation by leaf petiole cuttings based on our experiments between 2004 and 2006. Leaf petiole propagation is certainly not a new idea but one that we felt deserved a more systematic experiment to refine our knowledge of the subject.

KEY WORDS

Amorphophallus, leaf petiole cuttings, Araceae.

INTRODUCTIONS, SCOPE AND DETAILS OF THE PROJECT

Propagation of amorphophallus is accomplished primarily via seed. Some selected cultivars which are used as food crops, are propagated by tuber cutting (e. g. *A. paeoniifolius*), and others which offset freely can be propagated by natural offsets (for example, *A. albus, A. konjac*). Our experiments were designed to explore leaf petiole propagation as a faster and more economical method to build up selected clones of a wide array of species.

We began our first attempts at amorphophallus propagation in summer 2003, under the direction of our research supervisor, Petra Schmidt. Petra had used petiole cuttings when she worked at Missouri Botanical Garden, before coming to Plant Delights Nursery. We attempted to track down the origin of the use of leaf cuttings for reproducing amorphophallus and found that the idea seems to have come independently via many sources. My first knowledge of this technique goes back to a 1997 discussion of leaf petiole cuttings on Aroid-l, between Dewey Fisk, Kathy Upton, and Steve Marak. Kathy Upton of the University of Missouri, St. Louis, MO, then wrote a follow-up article for the Spring 1998 IAS Newsletter, describing her technique for leaf petiole propagation of *Amorphophallus titanum*. Tom Croat, however, remembers a paper from the 1970's by a Professor in Frankfurt, Germany, describing the technique, but we have not had luck locating the article or its details. Tom also indicated that the paper was also presented at a conference at the Missouri Botanic Garden. Additionally, Petra Schmidt remembers a traveling companion of Dr. Jim Symon that mentioned to her in the 1980's that he had seen amorphophallus leaves rooting on the ground during their travels in the tropics and that she should try the technique.

Before starting on the formal experiments, we experimented with stem, leaf, and leaf petiole cuttings and found that the leaf petiole cuttings gave the best results, compared to petiole cuttings or leaf cuttings with little or no petiole. Beginning in 2004, we tracked our results using only leaf petiole cuttings. From 2004–2006, we stuck 11,349 amorphophallus cuttings, which are recorded below (Table 1). Overall, the results were quite successful, and we will continue to refine our techniques and test more species in the upcoming years. We also hope that others will see fit to further expand on our findings.

Table 1. Continued.

Species	Source	Date stuck	Year	Hormone	# Stuck	# Rooted	% Rooted	Tuber size (cm)
A. bulbifer	Pradhan	8/5	2005	H #3	96	22	22.9	0.25–3.18
A. bulbifer 'Stemulation'	AGA-072	9/7	2006	H#3	103	103	100.0	1–2.0
A. bulbifer 'White Zebra'	T. McLamb	9/5	2006	H#3	48	36	75.0	1–4.0
A. bulbifer clumping clone	PDN	9/16	2005	H #3	48	26	54.2	0.25–2.54
A. bulbifer 'Metallica'	AGA-072	7/25	2005	H #3	96	80	83.3	2.54
A. bulbifer 'Pinkie'	T. McLamb	8/24	2006	H#3	96	89	92.7	0.5–2.0
A. bulbifer 'Pinkie'	T. McLamb	8/2	2005	H #3	68	42	61.8	0.25–0.5
A. bulbifer 'Pinkie'	T. McLamb	7/22	2004	H #1	24	22	91.7	2.0
A. bulbifer 'Pinkie'	T. McLamb	8/25	2004	H #1	4	4	100.0	1.0
A. bulbifer 'Pinkie'	T. McLamb	11/1	2004	H #1	12	12	100.0	0.7
A. carneus	HAM-464	7/16	2004	H #1	48	36	75.0	NA
A. carneus	HAM-464	9/5	2006	H#3	37	16	43.2	1.0–4.0
A. carneus	HAM-464	9/27	2005	H #3	96	38	39.6	2.54
A. carneus	AGA-1218	8/22	2006	H#3	3	3	100.0	1.0–1.5
A. coaetaneus	AGA-263	4/20	2004	H #1	48	22	45.8	2.5
A. corrugatus	AGA-709	8/5	2005	H #3	96	16	16.7	0.32–2.54
A. cruddasianus	AGA-550	9/7	2006	H#3	9	8	88.9	1.5–2.0
A. cruddasianus	AGA-550	9/20	2004	H #1	40	5	12.5	NA
A. cruddasianus	AGA-550	9/7	2005	H #3	48	5	10.4	0.5–2.54
A. cruddasianus	AGA-550	10/17	2005	H #3	48	0	0.0	0
A. curvistylis	Itsaul Nursery	10/17	2005	H #3	48	0	0.0	0
A. dunnii	PDN	8/9	2004	H #1	240	132	55.0	1
A. dunnii	PDN	8/25	2004	H #1	76	66	86.8	1.7
A. eichleri	AGA-922	9/5	2006	H#3	36	0	0.0	0
A. elatus	AGA-1033	12/6	2004	H #1	28	3	10.7	NA

Table 1. Continued.

Species	Source	Date stuck	Year	Hormone	# Stuck	# Rooted	% Rooted	Tuber size (cm)
A. excentricus	AGA-1057	9/27	2005	H #3	44	41	93.2	0.32–2.54
A. excentricus	HAM-184	9/5	2006	H#3	96	9	9.4	1.0–1.25
A. excentricus	HAM 184	8/5	2005	H #3	59	34	57.6	0.5–0.75
A. excentricus	AGA-1057	9/5	2006	H#3	38	4	10.5	1.00
A. excentricus	AGA-1057	9/7	2005	H #3	77	45	58.4	0.32–2.54
A. excentricus	AGA-1075	9/27	2005	H #3	47	14	29.8	0.32
A. fuscus	AGA-085	8/4	2006	H#3	39	5	12.8	0.5–1.0
A. fuscus	AGA-872B	10/17	2005	H #3	48	11	22.9	0.25–0.75
A. gigas	Itsaul Nursery	7/16	2004	H #1	96	32	33.3	1.6
A. gigas	Itsaul Nursery	8/9	2004	H #1	8	5	62.5	1.2
A. gigas	Itsaul Nursery	11/9	2004	H #1	48	0	0.0	0
A. glossophyllus	HAM-242	11/9	2004	H #1	36	2	5.6	NA
A. haematospadix	AGA-1039	12/6	2004	H #1	48	0	0.0	0
A. henryi	Croat-78320B	9/7	2005	H #3	80	17	21.3	0.25–0.5
A. henryi	D. Fisk	8/9	2004	H #1	85	4	4.7	0.8
A. henryi	AGA-085	8/30	2004	H #1	48	24	50.0	2.0
A. henryi (divisible tubers)	PDN	8/2	2005	H #3	56	68	121.4	0.32–0.75
A. henryi	AGA	8/9	2005	H #3	96	14	14.6	0.25
A. henryi	AGA-085	8/24	2006	H#3	121	92	76.0	0.5–2.5
A. henryi	AGA-085	8/4	2006	H#3	86	56	65.1	0.5–2.0
A. henryi	AGA-085	9/7	2005	H #3	128	48	37.5	0.32
A. henryi	Croat-78320B	8/4	2006	H#3	96	30	31.3	1.0–2.0
A. interruptus	HAM522	8/18	2006	H#3	48	48	100.0	1.0–2.0
A. kiusianus	AGA-080	10/17	2005	H #3	96	0	0.0	0
A. kiusianus	AGA-080	8/25	2004	H #1	96	8	8.3	NA
A. konjac 'Flesh Gordon'	PDN	8/5	2005	H #3	48	0	0.0	0

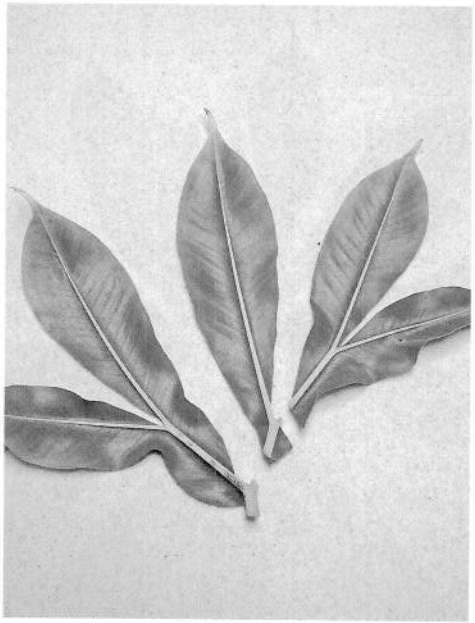

Fig. 3. Amorphophallus leaf further cut into three.

The medium in the cell packs was moistened well prior to the cuttings being stuck. After the cuttings were stuck, the trays were kept in a high humidity propagation house that was open to ambient temperatures, but kept cool with a polyethylene top cover and a 60% shade cloth. After October 15, the propagation greenhouse was covered in 4 mil polyethylene and heated to a minimum night temperature of 55°F (12.8°C). The trays of cuttings were never placed under mist, since our preliminary work in 2003 had shown that this increased the incidence of rot and did not positively affect rooting percentages (no data kept). The media was kept slightly moist and hand-watered as needed.

The tubers were harvested, counted, and measured in January, following the year in which the cuttings were taken.

ENCAPSULATION OF RESULTS

Amorphophallus aberrans - In two separate attempts, cuttings rooted from 20% in late August to 92.6% in early September.

Amorphophallus abyssinicus - We attempted this species only once, and cuttings stuck in early September rooted at 48.9%.

Amorphophallus albispathus - Cuttings taken in late August rooted the best at 99%, while cuttings taken in mid-October had rooting percentages from 0% to 42.5%. The difference in rooting percentages was probably due to differences in cutting quality, leaf maturity, or possibly clonal differences.

Amorphophallus asterostigmatus - Cuttings taken in early August rooted between 0% and 35.7%.

Amorphophallus atroviridis - Rooting percentages for this species were consistently low with the best results from cuttings taken in early July and the worst from cuttings taken in early September. The rooting percentage drop-off from early to late cuttings was quite dramatic in this species.

Amorphophallus brevispathus - This proved to be a very easy species to propagate from leaf petiole cuttings. Cuttings taken in early August rooted at 100%, dropping to 0% for cuttings taken in mid-October.

Amorphophallus bulbifer - Cuttings of this species generally rooted well. High percentages in the 80%–92% range were the norm when cuttings were taken early. Later cuttings taken in mid-October did not root unless a new shoot had emerged from the tuber. When this happened, we were able to obtain 100% rooting as late as early November.

Amorphophallus carneus - Cuttings taken the earliest rooted the best, with percentages dropping from 100% to 39.6% for the latest taken cuttings.

Amorphophallus coaetaneus - Cuttings from this species rooted at 45.8% for cuttings taken in April. We would expect this evergreen species to root throughout the season, but best percentages will probably come in early summer.

Amorphophallus corrugatus - Cuttings from this species were only taken once in early August, and they rooted at 16.7%.

Amorphophallus cruddasianus - Cuttings of this species rooted in a range from a high of 88.9% in early September to a low of 0% in mid-October.

Amorphophallus curvistylis - Cuttings were only attempted once, in mid-October, and resulted in no rooted cuttings. An earlier date should result in a higher rooting percentage.

Amorphophallus dunnii - Cuttings rooted at an average of 62.7% for August stuck cuttings. These were only tried using 1000 ppm IBA, but we would expect a higher percentage using 8000 ppm IBA.

Amorphophallus eichleri - Cuttings were taken only once in early September and did not root.

Amorphophallus elatus - Cuttings of this late-emerging species were stuck in December and rooted at 10.7%. We would expect this percentage to increase for summer cuttings.

Amorphophallus excentricus - Cuttings stuck in August and early September rooted the best with a high percentage of 58.4% and a low of 10.5%.

Amorphophallus fuscus - Cuttings stuck in both August and October rooted with percentages ranging from 12.8% to 22.9%.

Amorphophallus gigas - Cuttings taken in November rooted from a low of 0% to a high of 62.5% when taken in early August.

Amorphophallus glossophyllus - Cuttings were only attempted in early November, with a success rate of 5.6%. We would expect higher rooting percentages with early summer cuttings.

Amorphophallus haematospadix - Cuttings were only attempted once in December with none rooting.

Amorphophallus henryi - Cuttings taken in early August at rooted a high of 100%. Using the number of tubers as a count, the net was actually 121.4%. This figure is greater than 100%, since many of the cuttings formed more than one tuber. The lowest percentages were at 14.6%, also in early August. We feel that most of the discrepancy in rooting percentages was either due to clonal differences or, more likely, due to poor cutting quality.

Amorphophallus interruptus - Cuttings taken in mid-August rooted at 100%, but we have not re-tested this species.

Amorphophallus kiusianus - Cuttings of this species proved difficult to root with our highest percentage of 8.3% obtained with late August cuttings.

Amorphophallus konjac - Cuttings of this species also proved difficult, with our highest rooting percentages of 15.5% coming in early September.

Amorphophallus koratensis - Late and early season cuttings were a total failure, but cuttings taken in early August rooted at 38.9%.

Amorphophallus krausei - Rooting percentages ranged from a low of 0% in early September cuttings to 39.6% for early August cuttings.

Amorphophallus laoticus - Rooting percentages ranged from 19.2% to 56.5% for cuttings taken in early September.

Amorphophallus longiconnectivus - Rooting percentages ranged from 0% with early October cuttings to 46.7% for early September cuttings.

Amorphophallus longituberosus - We were never able to obtain higher than 22.2% rooting with this species with cuttings taken in mid-July. All cuttings taken later in the season failed to root.

Amorphophallus macrorhizus - We only attempted rooting this species once in early September and failed to root any cuttings.

Amorphophallus manta - This species rooted quite well in our only attempt in late August at 61.5%.

Amorphophallus margaritifer - We failed to root this species in our only attempt when cuttings were taken in early September.

Amorphophallus maxwellii - We had poor luck with this species, rooting only 3.3% from both early September and mid-October cuttings.

Amorphophallus muelleri - This was an easy to root species, with results ranging from 100% with July cuttings to 37.5% with early September cuttings.

Amorphophallus napalensis - We failed in our only attempt to root this species with cuttings taken in mid-August.

Amorphophallus obscurus - Our single attempt with early September cuttings resulted in 75% rooting.

Amorphophallus ochroleucus - Results with cuttings of this late-emerging species ranged from 0% in early February to 70% in mid-October. This should be a very easy species to root in mid-summer.

Amorphophallus operculatus - Results with this species ranged from 96.1% with early August cuttings to 2.1% with mid-October cuttings.

Amorphophallus paeoniifolius - This has proven to be a most difficult species to propagate from leaf blade cuttings. Of our 12 different attempts, only one was successful. One batch of early August cuttings resulted in 27.1% rooting.

Amorphophallus palawanensis - Our only attempt with this species in mid-October yielded no success.

Amorphophallus prainii - Our sole attempt with this species resulted in 5.4% rooting from early September cuttings.

Amorphophallus pusillus - Our only attempt with this species resulted in 40% rooting from cuttings taken in late August.

Amorphophallus putii - Our only attempt with this species resulted in 41.4% rooting from early August cuttings.

Amorphophallus pygmaeus - Of our five attempts with this species, three resulted in 100% rooting. One attempt with this species in very early August only resulted in 74.2% rooting.

Amorphophallus saururus - Our results with this species have been quite variable. We rooted it with 100% success on new growth in early November, but also failed to achieve any rooting on other attempts in October and November. Early August gave the next best results, with the percentages dropping rapidly after this time. We feel that the November rooting success was on newly emerging fall shoots.

Amorphophallus sizemoreae - Our best results with this species were from early August cuttings when we achieved 96.9% rooting. The percentages declined after this time, and we were not able to root this species in two attempts in early November.

Amorphophallus smithsonianus - We were able to root this species at 43.5% in our only attempt with early September cuttings.

Amorphophallus sumawongii - Our best luck with this species was with mid-July cuttings which rooted at 51.3%. By early September, our best rooting was at 28.6%.

Amorphophallus symonianus - The best luck with this species was with late August cuttings, which rooted at 85.7%. By mid-September, the rooting percentage had dropped to 42.4%.

Amorphophallus tenuispadix - In mid-July, we achieved 100% rooting, but that had dropped to 75% for cuttings taken in early August.

Amorphophallus tenuistylis - In three attempts, we have had no luck rooting this species, either in early August or early September.

Amorphophallus thaiensis - In 14 attempts, we have achieved results from 100% in early August to 0% in the same time frame. Early September cuttings range from 8.7% to 52.3%, and plants with new growth rooted 81.3% from early November cuttings.

Amorphophallus tonkinensis - We have had relatively good luck rooting this species, both with early September and early October cuttings with 81.3% success in our best attempt.

Amorphophallus variabilis - Our results with this species ranged from 51.6% with early September cuttings to 0% for mid-October cuttings.

Amorphophallus verticillatus - In our single attempt with this species, we achieved 100% rooting from mid-November cuttings.

Amorphophallus yuloensis - In our six attempts to root this species, only our mid-November attempt failed completely. Our best results were from early November cuttings when we achieved 100% and 83.3% rooting in two separate attempts.

Amorphophallus yunnanensis - Our four attempts with this species have yielded mixed results, ranging from 100% rooting from mid-September cuttings to 0% on two attempts with early October and early September cuttings. We feel the failure in early September was either due to poor quality cuttings or improper care while rooting.

SUMMARY/DISCUSSION

Based on our results, it appears that leaf petiole cuttings will root for virtually all species of *Amorphophallus* tested, although many more still need to be tried. We will continue our work in this area. It is difficult to make statistically valid comparisons even within species due to the uneven nature of amorphophallus emergence from dormancy. There is no question that some species are much more difficult to root than others. Our experiments confirmed that cuttings rooted best just after the new leaf growth had hardened, approximately 4 weeks after emergence. In our 2003 preliminary tests, we found that cuttings taken too early simply dissolved within the first week.

Even with proper timing, some of the most difficult to root species include: *A. atroviridis*, *A. corrugatus*, *A. kiusianus*, *A. konjac*, *A. krausei*, *A. longituberosus*, *A. maxwellii*, *A. napalensis*, *A. paeoniifolius*, and *A. tenuistylis*. It was interesting that winter hardiness reflected a trend of also being difficult to root from leaf petiole cuttings. The only exceptions to this rule were *A. bulbifer*, *A. henryi*, and *A. thaiensis*. More work is needed to better understand if there is a correlation between winter hardiness and rooting or if timing is simply more critical.

With proper timing, these species rooted at the highest percentages: *A. albispathus*, *A. brevispathus*, *A. interruptus*, *A. muelleri*, *A. bulbifer*, *A. operculatus*, *A. pygmaeus*, *A. sizemoreae*, *A. tenuispadix*, and *A. verticillatus*.

Cuttings were taken where the leaf branched into three segments from the main petiole. We typically took two of the three segments from each plant, leaving one attached to supply energy to the bulb. When we did so, the remaining segment remained green and eventually senesced normally. When we took all three segments, a rapid emergence of a new petiole and leaf followed. If the older leaf is too mature to obtain quality cuttings, the older leaves and/or petiole can be removed to force a new leaf from the tuber. This appears to be a result of eliminating the auxin inhibition that typically keeps a new leaf from emerging from the tuber. If the plant is nearing its dormant season, resprouting will not take place. We did not keep accurate records of which species resprouted and their timing, but our observations are in contrast to those of Wilbert Hetterscheid of the Netherlands, whose plants have not exhibited this behavior. The difference in behavior could be due to a more conducive climate for growing amorphophallus (warmer and more humid conditions), or simply one of timing of the cut petioles.

Fig. 4. *Amorphophallus tonkinensis* cutting with roots.

After the cuttings were stuck in the soilless media, rooting usually began in about 2 weeks, with tuber formation taking about 8–16 additional weeks (Fig. 4). Two of the species which produced tubers the fastest (around 6 weeks) were *A. bulbifer*

Fig. 5. *Amorphophallus pygmaeus* rooted, with new tuber.

and *A. thaiensis*. These two species developed a basal swelling of the cutting/ tuber initiation about the same time as rooting occurred. Once the tuber was large enough to support itself, the leaf senesced. Most species did not produce a new leaf until the newly formed tuber had undergone dormancy. The exceptions are species with longer growing periods such as *A. operculatus*, and *A. coaetaneus* (Fig. 5). When the tubers were harvested in January, we noted that the cuttings of some species that were stuck after mid-September often had not completed their tuber development. In these cases, the leaf petiole cutting was still green. When the leaf has not died back naturally, these cuttings must be kept growing in slightly moist soil through the first winter, or until the leaf completely turns brown. If not, we have found that the developing tubers are too small to survive and will usually desiccate and die.

Other variables for future research would be to examine clonal rooting differences within a species. This is well documented for many genera, but to our knowledge has not been examined for amorphophallus. The challenge will be to have a large enough stock of cutting material that emerges simultaneously. We hope this research will enable more unique forms of amorphophallus to be propagated and distributed, as well as rare species being propagated for *ex-situ* conservation.

We would like to thank the following for their assistance and encouragement with this project: Lynn Butler, Alan Galloway, Brienne Gluvna, Amber Harmon, Petra Schmidt, Gretchen Sedaris, Aaron Selby, Mike Spafford, and the Aroid-l Contributors.