



A new *Amorphophallus* (Araceae) species from Thailand and an updated key to the Longituberosus and Saraburiensis subclades

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Abstract

Amorphophallus is a genus of 239 species distributed across the African, Asian, and Australian continents. A new species, *Amorphophallus bantae*, from the Sa Kaeo province of Thailand is described and illustrated. The species is compared to morphologically similar species in the Longituberosus and Saraburiensis subclades and an updated key to these species is provided.

Key words: aroids, monocots, taxonomy, *Scutandrium*

Introduction

The genus *Amorphophallus* Blume ex Decaisne (1834: 366) contains 239 currently accepted species (Scholten 2023), making it one of the most species-rich genera in Araceae (Boyce & Croat 2011). Although the genus was first erected by Blume in 1834 more than half of all the species were described within the last 50 years with species still being described annually (Naive *et al.* 2022, Serebryanyi *et al.* 2023). The greatest taxonomic diversity occurs in Southeast Asia with notable diversity also occurring in Central Africa. Thailand is particularly rich in *Amorphophallus*, with at least 60 documented species and likely many more yet to be described (Scholten 2023).

The Longituberosus and Saraburiensis subclades, as defined by Claudel *et al.* (2017), contain seven accepted species (*A. albispachus* Hetterscheid (1994: 239), *A. coudercii* Bogner (1986: 75), *A. longituberosus* Engler & Gehrman (1911: 73), *A. saraburiensis* Gagnepain (1941: 122), *A. scutatus* Hetterscheid & Chapman (2001: 270), *A. tenuispadix* Hetterscheid (1994: 277) and *A. tenuistylis* Hetterscheid (1994: 279)) distributed across Cambodia, Thailand, and Vietnam.

The Longituberosus and Saraburiensis subclades form a monophyletic group within the *Amorphophallus* subgenus *Scutandrium* Hetterscheid & Claudel in Claudel *et al.* (2017: 40) and are phylogenetically sister to the former *Pseudodracontium* Brown (1882: 193) group of species (Claudel *et al.* 2017), which were recently subsumed into *Amorphophallus* based on morphological (Hetterscheid & Claudel 2012) and molecular evidence (Sedayu *et al.* 2010, Claudel *et al.* 2017). The monophyly of species in the Longituberosus and Saraburiensis subclades is supported by molecular data (Claudel *et al.* 2017) and on the basis of shared morphological characters including an elongate tuber, medium inflorescence size, spathe base interior with elongate papillae, spathe base and limb being separated by little to no constriction, and stigmas with pronounced styles (Hetterscheid 2012, Scholten 2023).

One of the only characteristics separating the two clades is the biochemical profile of odors released from the appendix at anthesis. An anise-like odor (4-methoxyphenethyl alcohol) is produced by species of the Longituberosus subclade, while species of the Saraburiensis subclade tend to smell sweet (attributed to 1-phenylethanol) (Kite & Hetterscheid 1997, Kite & Hetterscheid 2017). After considering the shared morphological characters of species in the Longituberosus and Saraburiensis subclades, the placement of *Amorphophallus bantae* **sp. nov.** into one of these

clades is well supported. The odor profile of *A. bantae* (vaguely citrus-like) has yet to be chemically characterized and therefore the species is morphologically compared to species in both subclades.

Materials and methods

Initial fieldwork to collect the species was conducted at the type locality in October of 2000. A group of individuals was maintained in *ex-situ* cultivation for 23 years in the collection of the late John Banta before *species nova* status was determined. Photo-documentation and morphological description of the species was done *ex-situ* at Cornell University in Ithaca, New York. Herbarium specimens were prepared using a standard Araceae protocol outlined by Croat 1985. The holotype and paratypes were deposited at the Bailey Hortorium Herbarium (BH).

Taxonomy

Amorphophallus bantae J.T.Scholten, D.W.Livingston & Sizemore, *sp. nov.*

(Figs. 1, 2)

Similar to *Amorphophallus tenuistylis* in general morphology and habit, but differs by having an overall smaller inflorescence, elliptic spathe with vertical stripes and a mucronate limb apex (rather than a lanceolate unstriped spathe with an acute apex), a spadix as long or slightly shorter than the spathe (in contrast to a spadix distinctly longer than the spathe), and congested pistillate flowers with shorter (ca. 1 mm long) styles (as opposed to sparsely arranged pistillate flowers with long (3–4 mm) styles).

Type:—UNITED STATES OF AMERICA. Florida, Fort Myers, from a plant cultivated by D.W.Livingston from the collection of John Banta, 28 Apr. 2023, *Justin Scholten 366* (orig. living coll.: THAILAND. Sa Kaeo Province, North of Ta Phraya District, 125 m, N14°7'21.23" E102°40'33.48, 15 Oct. 2000 (holotype BH!)

Tuber napiform to elongate, 5–8 cm long, 3–5 cm diam. *Petiole* 25–32 cm long, 0.8–1.2 cm diam, surface glabrous, green with numerous vertical whitish/light green stripes. *Lamina* 41–46 cm diam, rachises narrowly winged proximally and distally; leaflets ovate to elongate elliptical, 22–32 cm long, 24–28 cm wide; foliolules ovate to lanceolate, adaxial surface slightly darker green than abaxial surface, collective vein distant from margin, 32–40 foliolules per leaflet. *Inflorescence* solitary; peduncle 28–34 cm long, 6–9 mm in diam at the base, glabrous, with purple vertical stripes grading to green, 0.25–2.00 mm in diam, and whitish ovoid mottles, ca. 0.25 mm in diam. *Spathe* elliptical-cuneate, 14–16 cm long, 2.5–3.5 cm in diam, erect, base and limb separated by a shallow constriction, exterior dark green with purplish vertical stripes, 0.25–2 mm in diam, and whitish ovoid mottles, 0.25 mm in diam (as peduncle), limb interior as exterior but without stripes or mottles, base interior light purple/red and distinctly verrucose. *Spadix* sessile, as long or slightly shorter than spathe, 13–15 cm long; pistillate zone cylindrical, 2–3 cm long, 0.75–1.25 cm diam, pistils crowded; staminate zone cylindrical, 5–6 cm long, 0.75–1.25 cm diam, stamens crowded; appendix cylindrical, 5.5–6.5 cm long, 0.4–0.6 cm diam, purplish-brown, glabrous toward apex, slightly corrugated at base, apex mucronate, emitting a vague citrus-like odor at anthesis. *Ovaries* depressed-globose, 1.8–2.1 mm diam, 1.2–1.4 mm long, light green, 2–3-locular; style ca. 1 mm long, slightly angulate, purple; stigma depressed, 1.2–1.4 mm diam, 0.2–0.3 mm high, 2–3 lobed, surface covered densely in fleshy projections, yellow to pale brown. *Male flowers* consisting of 2–6 stamens, lowermost stamens slightly enlarged, 2–5 mm long, 2–5 mm diam; filaments ca. 1 mm long, up to 2 mm long in lowermost flowers; anthers reddish-purple, 1.5–2.5 mm long, 1.25–2 mm diam, connective slightly depressed, pores apical, elongate. *Fruits* not observed.

Climate:—The province of Sa Kaeo experiences a seasonal tropical climate with the rainy season typically lasting from May through October, dry season from November through January, and summer from February through April. The mean annual air temperature in Sa Kaeo is among the highest of the provinces in this region, averaging 28.4° C, while the average humidity and rainfall is among the lowest, 74.5% and 1404 mm respectively (Phattraporn *et al.* 2016).

Geography:—Sa Kaeo comprises an approximate area of 7,200 square kilometers in southeastern Thailand and is geographically diverse, with both flat plains in the south and the Khao Ban Thad mountains in the north (ranging in elevation from 74 m and 740 m respectively). The mountainous region in the northern sector of the province gives

origin to the Bang Pakong River, an ecologically important watershed within the province (Chaikongthong *et al.* 2015). The type locality for this species occurs in an open lowland valley between the Khao Sakae Krong (480 m) and Khao Thing Kap (305 m) mountains at an approximate elevation of 100–150 m.

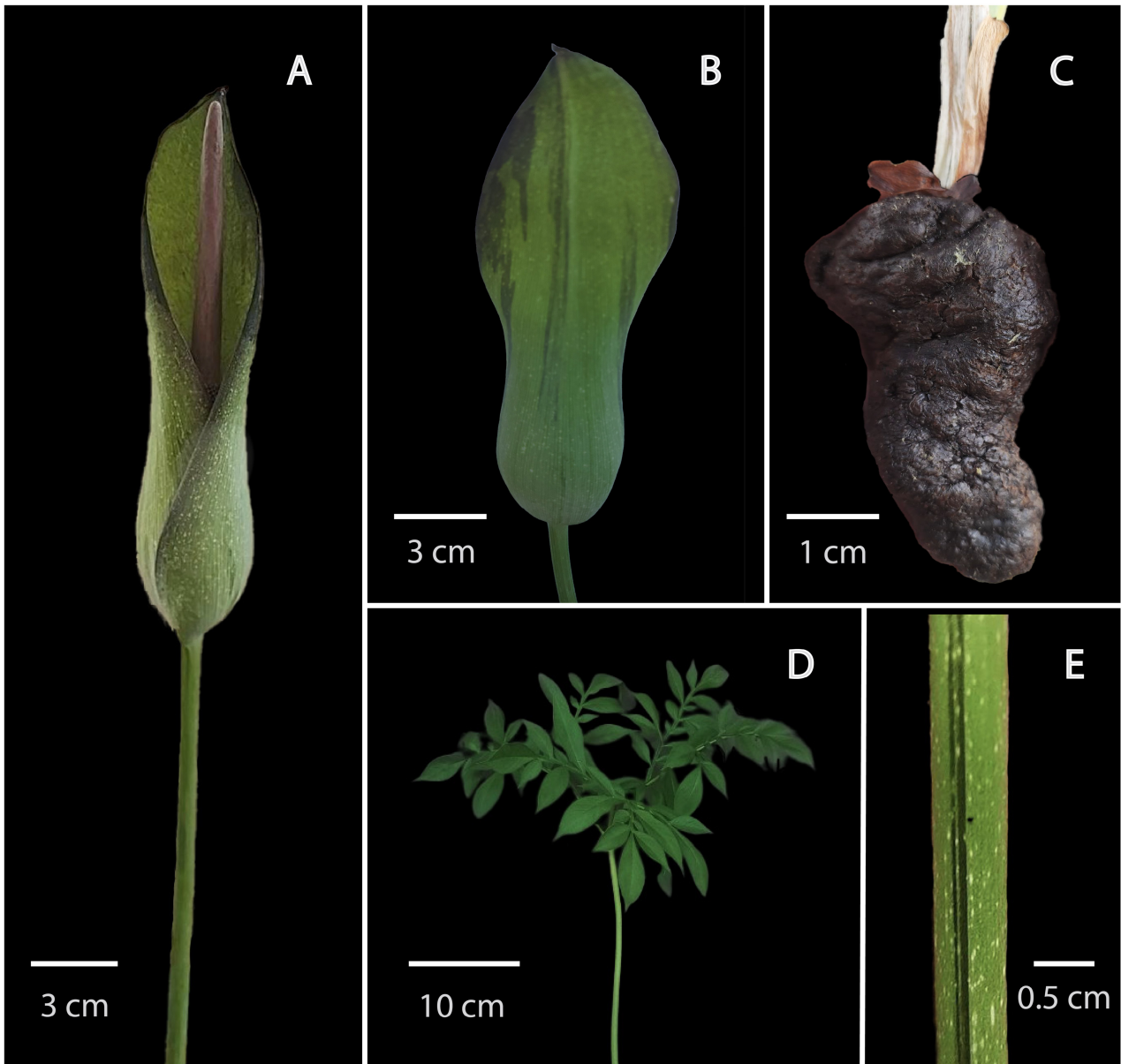


FIGURE 1. General habit of *Amorphophallus bantae*. A. Inflorescence: front view; B. Inflorescence: back view; C. Tuber; D. Leaf; E. Petiole.

Distribution:—Known only from this type locality in the Ta Phraya district of Sa Kaeo province, Thailand.

Eponymy:—The epithet of this species honors John Banta, a superb plantsman, for his contribution to Araceae conservation and discovery of this species.

Morphological affinities:—*Amorphophallus bantae* shares some degree of morphological similarity with all members of the Longituberosus and Saraburiensis subclades within the subgenus *Scutandrium*, including having an elongate tuber, medium inflorescence size, spathe base interior with elongate papillae, spathe base and limb being separated by little to no constriction, emission of citrus-like odor from the appendix at anthesis, stigmas with pronounced styles, and elongate thecae pores. It differs from *A. saraburiensis* and *A. scutatus* in not having sterile synandrodes present between the pistillate and staminate zone and a spadix that is as long or shorter than the spathe (versus distinctly longer)—important diagnostic characters in the genus. *Amorphophallus bantae* can be easily distinguished from *A. tenuispadix* and *A. albispadix* in having a striped spathe and peduncle, reddish appendix, and purple styles. Although similar to *A. longituberosus* in having a striped spathe and peduncle, short spadix, and 3-locular ovary, *A. bantae* can be discriminated by the presence of a reddish appendix, purple styles, and depressed ovaries.

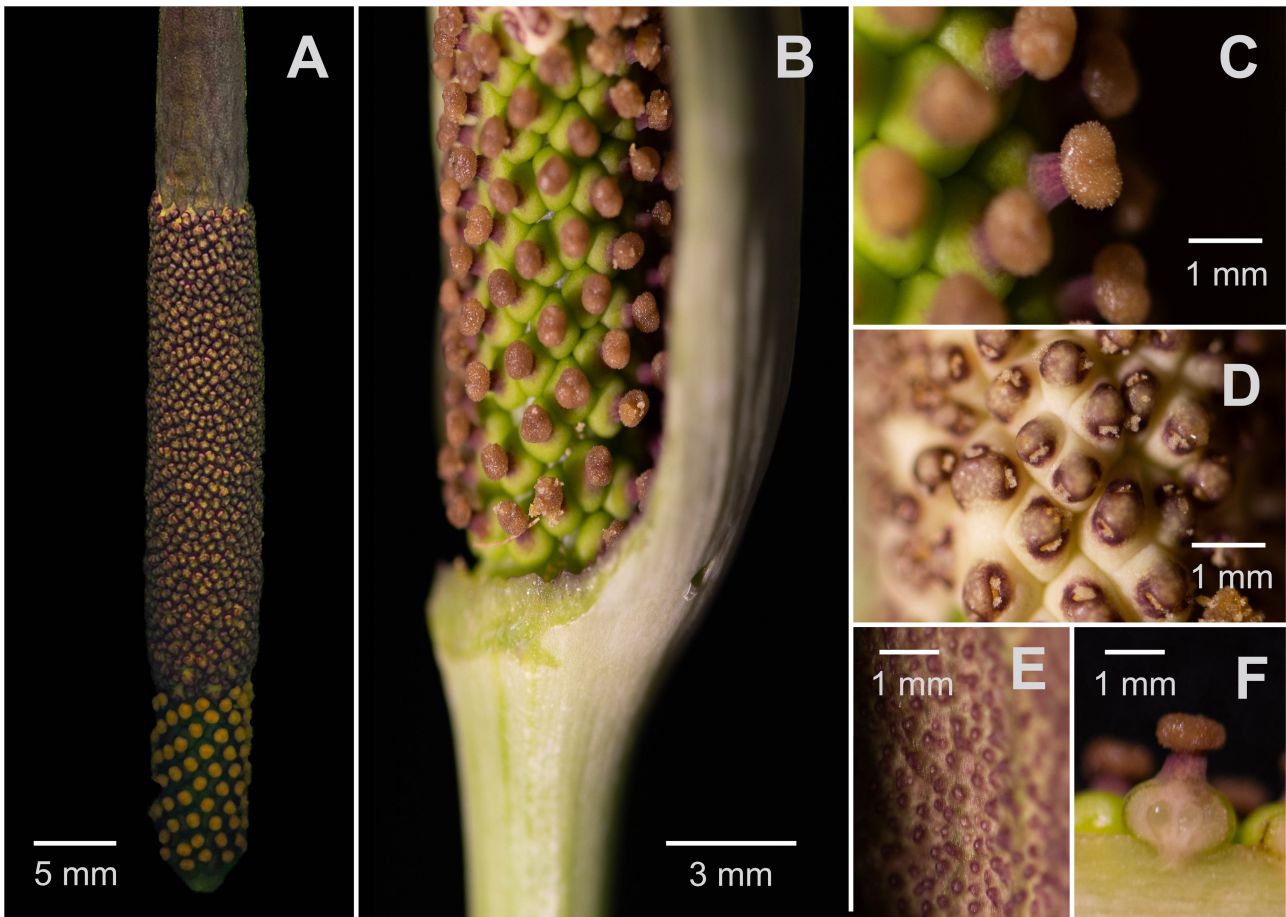


FIGURE 2. Spadix morphology of *Amorphophallus bantae*. A. Spadix with excised spathe; B. Closeup view of pistillate zone of spadix with partially excised spathe; C. Pistillate flowers; D. Staminate flowers; E. Spathe base verrucosity; F. Longitudinal section of an individual ovary.

Amorphophallus tenuistylis perhaps shares the closest morphological affinity with *A. bantae*, both species share a mottled peduncle and spathe, reddish appendix, purplish spathe base interior with pronounced warts, 2–3-lobed stigma, and reddish-purple style; however, *A. bantae* has an overall smaller inflorescence, elliptic spathe with vertical stripes and a mucronate limb apex, a spadix as long or slightly shorter than the spathe, and congested pistillate flowers with shorter (ca. 1 mm long) styles (for full comparison, see table 1).

TABLE 1. Morphological comparison of *Amorphophallus bantae* and closely related species.

	<i>A. bantae</i>	<i>A. tenuistylis</i>	<i>A. longituberosus</i>	<i>A. albispathus</i>	<i>A. tenuispadix</i>
Peduncle length	28–34 cm	64–88 cm	10–76 cm	20–40 cm	11–29 cm
Peduncle exterior	light green with purple vertical stripes and small whitish mottles	olive green with small grayish mottles	gray or light pink with green or brown mottles and (often) dark vertical stripes	uniformly pink or olive-green grading up to pink	light brown to pinkish with few to many dark elongate mottles
Spadix length	13–15 cm	24–48 cm	5.0–15.5 cm	8–13 cm	5.5–12.0 cm
Spadix-spathe ratio	spadix as long or shorter than spathe	spadix longer than spathe	spadix as long or shorter than spathe	spadix shorter than spathe	spadix as long or shorter than spathe
Appendix size	5.5–6.5 cm long, as broad or narrower than staminate zone	16–30 cm long, as broad or narrower than staminate zone	2.5–8.0 cm long, as broad or broader than staminate zone, never narrower	2–8 cm long, much broader than staminate zone	1.5–4.0 cm long, much broader than staminate zone
Appendix color	purplish-brown	reddish-purple	whitish-beige	whitish-beige	whitish-beige

.....continued on the next page

TABLE 1. (Continued)

	<i>A. bantae</i>	<i>A. tenuistylis</i>	<i>A. longituberosus</i>	<i>A. albispachus</i>	<i>A. tenuispadix</i>
Spathe length	14–16 cm	19–40 cm	5–20 cm	6–14 cm	5–13 cm
Spathe shape	elliptic	lanceolate	elliptic to elongate triangular	triangular-ovate	elliptic to lanceolate
Spathe limb apex	mucronate	acute or acuminate	acute	acute or acuminate	acute or acuminate
Spathe exterior	uniformly dark green with purplish vertical stripes and small whitish ovoid mottles	limb reddish-brown with small dark mottles; base grayish-green with small gray mottles	uniformly light green or gray with or without large brownish-green mottles or vertical stripes	uniformly greenish- white or pinkish-white, occasionally grading to darker pink toward base	greenish-gray or pinkish gray (rarely white) with or without large dark ovoid mottles
Spathe interior	limb uniformly dark green; base reddish- brown with elongate warts.	limb uniformly reddish- brown; base dark purple with long, (often branched) warts	limb uniformly light green or gray; base as limb or reddish with small elongate warts	as exterior or occasionally paler with small elongate warts	as exterior or paler, base typically without mottles and loosely verrucose
Pistillate flower density	congested	sparse; ovaries 1–4 mm apart	congested	congested	congested
Ovaries	2–3-locular	3-locular	3-locular	3–4-locular	1-locular
Stigma shape	depressed; 2–3 lobed	hemispheric; 2–3 lobed	flattened; 3–4 lobed	flattened; 3–4 lobed or bilabiate	discoid; bilabiate
Stigma color	dark yellow to pale brown	bright yellow	bright yellow	white or yellow	white or yellow
Style length	ca. 1 mm	3–4 mm	2–3 mm	ca. 1 mm	ca. 1 mm
Style color	reddish-purple	reddish-purple	green	green	green

Other specimens examined (paratypes):—UNITED STATES OF AMERICA. Florida, Fort Myers, from a plant cultivated by D.W.Livingston from the collection of John Banta, 13 June 2023, *Justin Scholten 425*. From same plant as *Justin Scholten 366* (type) (orig. living coll.: THAILAND. Sa Kaeo Province, North of Ta Phraya District, 125 m, N14°7'21.23" E102°40'33.48, 15 Oct. 2000 (paratype BH!); Florida, Fort Myers, from a plant cultivated by D.W.Livingston from the collection of John Banta, 28 July 2023, *Justin Scholten 455*. From same plant as *Justin Scholten 366* (type) and *Justin Scholten 425* (paratype) (orig. living coll.: THAILAND. Sa Kaeo Province, North of Ta Phraya District, 125 m, N14°7'21.23" E102°40'33.48, 15 Oct. 2000 (paratype BH!).

Discussion

The combination of a striped spathe with little to no constriction separating the base and limb, spadix as long or shorter than the spathe, reddish appendix, elongate thecae pores, congested green ovaries, and 2–3-lobed stigmas with purple styles distinguish *A. bantae* from all other species in the genus. It should be noted that some species in this group (i.e., *A. longituberosus* and *A. tenuispadix*) can be quite variable in morphology. The variation among individuals of *A. tenuispadix* can be so severe, that certain forms may be indistinguishable from *A. albispachus* aside from the number of ovary locules. The observed variation within the characters expressed by *A. bantae* does not seem to encroach the morphological species boundary of any taxon in either subclade, reinforcing its status as a *species nova*. It should be noted however that *A. bantae* was described from a small ex-situ population and morphological variation may be higher in wild populations not observed. Future molecular analyses aimed at discriminating genetic variation within and between subclades should be pointed here.

Key to the species of the Longituberosus and Saraburiensis subclades of *Amorphophallus* subgen. *Scutandrium*

Species treated:

A. albispachus (Thailand)

A. bantae (Thailand)
A. coudercii (C. Vietnam, Cambodia)
A. longituberosus (NW Malaysia, Thailand)
A. saraburiensis (C. Thailand)
A. scutatus (C. Thailand)
A. tenuispadix (C. Thailand)
A. tenuistylis (C. Thailand)

1. Spadix distinctly longer than spathe; synandrodes present or not.....2.
- Spadix as long or shorter than spathe; synandrodes absent.....4.
2. Spathe base interior covered in fleshy, hair-like projections; synandrodes often absent *A. tenuistylis*
- Spathe base interior verrucose; synandrodes always present3.
3. Styles short, 1–2 mm long *A. saraburiensis*
- Styles 3–4 mm long *A. scutatus*
4. Appendix absent *A. coudercii*
- Appendix present.....5.
5. Appendix reddish-brown, less broad than staminate zone *A. bantae*
- Appendix white or beige, at least 1.25× as broad as staminate zone6.
6. Staminate pores located at the periphery of thecae; spathe exterior often with vertical stripes.....*A. longituberosus*
- Staminate pores located near the center of thecae; spathe exterior always without stripes7.
7. Ovaries 3–4-locular; peduncle and spathe without mottles.....*A. albispadix*
- Ovaries unilocular; peduncle and/or spathe often mottled*A. tenuispadix*

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