

Notes on the Genus *Amorphophallus* (Araceae)

15. New Species from SE Asia

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ABSTRACT

Fourteen new species of the genus *Amorphophallus* are described from SE Asia, based mainly on material in existing living collections. The affinities of the species to existing ones are discussed.

KEY WORDS

Araceae, *Amorphophallus*, taxonomy, SE Asia.

INTRODUCTION

During the preparation of the full taxonomic revision of *Amorphophallus*, 14 new species were discovered in existing collections of Mr. Alan Galloway (North Carolina, USA), Mr. Tim Musi (USA), Mrs. Mary Sizemore (Florida, USA), Dr. Nguyen Van Du (Vietnam) and Mr. Sappasiri Chaovanich (Thailand). Some of these were growing already in the collection of living plants of the Wageningen University Botanical Gardens, others were diagnosed using pickled specimens and pictures sent by the owners. Some were invited to be joint authors of some of the species names, and additionally one species was named after Mr. Alan Galloway for his extensive contributions to the revision of the genus by the author. Dr. M. M. Serebryanyi (Moscow, Russia) co-authored one species because of his extensive knowledge of the group of species to which one of the newly described species belongs.

DESCRIPTIONS

1) *Amorphophallus croatii* Hett. & A. Galloway **sp. nov.** Type: from a plant

cultivated by A. Galloway (orig. coll.: LAOS, Bolikhamxay & Khammouane Provinces, in heavy shade, in rather wet and heavy soils, A. Galloway), 13 September 2004, *Galloway AGA-1741-01-T* (holotype, WAG, spirit collection.). Figures 1–3.

Morphologia *A. tonkinensem* approximata, habitu ubique infirmiore, staminibus multo brevioribus, petiolo sine maculis prominentibus nigris differt.

Tuber depressed-globose, 6 cm in diam., 4 cm high, no offset development. Petiole 35–50 cm long, to 2 cm in diam., smooth, background a very fine pattern of tiny pale and dark green spots, with superimposed scattered larger, irregular, pale whitish green spots, the junction of petiole to the rachises of the lamina occasionally swelling to form an intercalary bulbil; lamina highly dissected, 60 cm wide, rachises winged distal from the basal branching points; leaflets elongate-elliptic, 4–16 cm long, 2–5.5 cm wide, acuminate, upper surface glossy green. Inflorescence solitary, after a very short leafless dormancy period; peduncle as petiole but considerably thinner, 35–40 cm long, ca. 5 mm in diam.; spathe ovate, 10–13 cm long, 7–8 cm wide, outside pale green, margins whitish green, inside pale green, base inside ridged-verrucate, apex broadly acute. Spadix slightly shorter than or equaling the spathe, sessile; female zone subcylindric, slightly wider at the apex, 1.4–1.5 cm long, 1–1.1 cm in diam., flowers congested; male zone subcylindric, slightly widening at the apex, 1.7–1.9 cm long, 1.2–1.3 cm



Fig. 1. *Amorphoballus croatii* Hett. & A. Galloway. Inflorescence. Photograph by A. Galloway.



Fig. 2. *Amorphoballus croatii* Hett. & A. Galloway. Spadix (spathe cut open). Photograph by A. Galloway.

Distribution—Only known from the type locality.

Additional Specimen Examined—Type locality, from a plant cultivated in the Botanical Gardens of Wageningen University (orig. coll. by A. Galloway), *Hetterscheid H.AM.1432* (WAG).

Etymology—The species epithet celebrates our friend and great aroid scientist, Thomas B. Croat of the Missouri Botanical Garden, whose prodigious work on South American Araceae is unmatched and inspiring.

Notes—*Amorphoballus croatii* is obviously close to *A. tonkinensis* Engl. & Gehrm. (N. Vietnam, S. China) with which it shares the typical colour pattern of the petiole, the shape of the spathe and the appendix shape. The differences being the much smaller dimensions in general of *A. croatii* and the much longer stamens in *A. tonkinensis*. Additionally *A. croatii* lacks

in diam., flowers congested; appendix more or less cylindric-fusiform, 6.5–6.7 cm long, 1.5–2 cm in diam., obtuse, smooth, white. Ovary depressed, 3 mm in diam., 1.5 mm high, green, bilocular; style 1–1.2 mm long, 1 mm in diam., pale green; stigma depressed, 1.5 mm in diam., 0.5 mm high, entire with or without a very small central depression, verrucate, pale yellowish. Male flowers consisting of 3–4 stamens; stamens 1.5 mm long; filaments 0.5 mm long, fused entirely, white; anthers 1 mm long, 1–1.5 mm in diam., white, pores apical, oval. Pollen psilate.



Fig. 3. *Amorphoballus croatii* Hett. & A. Galloway. Spadix, female zone.



Fig. 4. *Amorphoballus fuscus* Hett. Inflorescence.

the black, raised spots in the lower part of the petiole as found typically in *A. tonkinensis* and the latter has so far rarely been observed to form intercalary bulbils in the leaves.

2) *Amorphoballus fuscus* Hett. **sp. nov.** Type: collected from a living plant at the Botanical Gardens of Wageningen University (orig. coll.: a living plant in the private coll. of T. Musi, USA, said to have been found "on limestone cliffs in NORTHERN THAILAND between Thailand and Burma"), 22 March 2005, *Hetterscheid H.A.M.1294-T* (holotype, WAG, spirit collection.). Figures 4–6.

Amorphoballo asterostigmate, *A. carneae*, *A. krausei*, admodum forte similes, ab omnibus tribus stigmatato laterali bilabiato, floribus masculinis functionalibus sed in-crassatis differt.

Tuber depressed globose, 4–10 × 4–7

cm, dark brown, offsets rhizomatous, to 15 × 1.5 cm, scaly. Petiole 34–70 × 1–2 cm. smooth, mauve with dark brown to dark reddish brown, scattered, elongate oval or oval spots; lamina 52–80 cm in diam. rachises winged above the basal branchings; leaflets elliptic to elliptic-lanceolate, 5–20 × 2–5 cm., broadly acuminate, with short apiculum, upper side green, venation visibly highly reticulate. Inflorescence long-peduncled; peduncle 16 cm long, 7 mm in diam., smooth, brown with scattered, elliptical very dark brown spots; spathe erect, base and limb not separated, shallowly convolute in the lower part, ovate, 10 cm long, 7 cm wide, acute, outside glossy brown, the lower part with very few, scattered, small, orbicular dark brown spots, upper part darker brown towards the margin, inside pale dirty yellow-green, the base dark maroon, with several very shallow warts. Spadix sessile, as long as the spathe, 10 cm long; female zone cylindrical, 12 mm long, 12 mm in diam., flowers



Fig. 5. *Amorphoballus fuscus* Hett. Spadix (spathe cut open).



Fig. 6. *Amorphoballus fuscus* Hett. Spadix (detail of base).

congested; male zone subcylindric, slightly narrowing to the apex, 3 cm long, 12 mm in diam., flowers congested; appendix cylindrical-conical, base attenuate, apex rounded, 5.8 cm long, 1.5 cm in diam. above the base, smooth, lower part with shallow, more or less diamond-shaped staminodes, diminishing upwards, surface off-white, developing a strong oligomethyl-oligosulphide smell. Ovaries 4–5-angulate, apex hemispheric, 2–2.5 mm high, 2 mm in diam., base white, otherwise dirty purple, unilocular; style elongate conical, held almost parallel to the spadix, 1.5–2 mm long, 1 mm in diam. at the base, 0.8 mm diam. at the middle, apex slightly expanded and shallowly lobed, pale green, base dirty purplish; stigma very thin, 0.3 mm high, 1 mm in diam., draped over the lobes of the style apex, radially 3–4-lobed-sinuate, shallowly verrucate, dirty pale greyish. Male flowers consisting of 3–5 stamens; stamens 2.5 mm long; filaments thick, fused entirely, 2 mm long, 2 mm in

diam., those of the lower flowers much broader, up to 5 mm in diam., off-white; anthers truncate, 0.5 mm long, 1 mm in diam., off-white suffused with pale dirty purple; connective broad, off-white; pores slit-like, marginal. Pollen striate.

Distribution—Only known from the uncertain geographical data on the type specimen.

Etymology—The species epithet refers to the colour of the outer surface of the spathe.

Notes—*Amorphoballus fuscus* shows a suite of characters that link it morphologically to such species as *A. asterostigmatus* Bogn. & Hett. (Central Thailand), *A. carneus* Ridl. (S. Thailand & Malaysia), *A. excentricus* Hett. (S. Thailand), *A. krausei* Engl. (Burma, N. Thailand, SW China, Laos). This group has rather undifferentiated erect spathes, spadix as long as or shorter than the spathe and elongate con-



Fig. 7. *Amorphophallus gallowayi* Hett. Inflorescence. Photograph by A. Galloway.

ical appendices. Tubers are depressed-globose or subglobose and offsets are numerous, fusiform or rhizomatous. The strong smell is similar in all. *Amorphophallus fuscus* differs from all these by the orientation of the style, the very thin small stigma and the enlarged filaments in the lower male flowers. Furthermore it has a much more dense reticulate higher order venation in the leaflets.

The typical style and stigma of *A. fuscus* is found in *Amorphophallus* only in *A. corrugatus* N.E. Br. and *A. kachinensis* Engl. from N. Thailand, Burma, SW China. However, both of these species have near-globose appendices with strong convolutions or corrugation. The enlarged filaments of the lower flowers is found in *Amorphophallus* in the *A. longituberosus*-alliance,



Fig. 8. *Amorphophallus gallowayi* Hett. Spadix (spathe cut open). Photograph by A. Galloway.

species of which have elongate tubers and a scent of anise. The enlarged filaments probably serve as food for the pollinators and are likely homologous to the staminodes in *A. krausei* and several other species.

3) *Amorphophallus gallowayi* Hett. **sp. nov.** Type: from a plant cultivated by A. Galloway (orig. coll.: LAOS, Khammouane Province, A. Galloway), 26 June 2005, *Galloway AGA-1569-01-T* (holotype, WAG, spirit collection.). Figures 7–9.

Amorphophallus gallowayi species in genere singularis baccis maturescentibus e albis ad purpureos ad azureos mutantibus. Appendix zona mascula relative brevissima solo in *A. koratensis* et *A. napigero* occurrit. *Amorphophallus koratensis* tuberem globosum gaudet dum *A. napigero* tuberem longissimum folia lanceolata cinereoovariata habet.



Fig. 9. *Amorphoballus gallowayi* Hett. Spadix (lower part with female and male zone). Photograph by A. Galloway.

Tuber more or less globose, 3 cm long, 3 cm in diam., pale brown, no offset development. Leaf solitary; petiole, 25 cm long, 6 mm in diam., uniformly deep rich burgundy red, longitudinally ridged, ridges with shallow elevations making the petiole feel slightly rough; lamina moderately dissected, 32 cm across, rachises winged from the basal branchings; leaflets elliptic to elongate elliptic, 2–14 cm long, 1.4–4 cm wide, acuminate, slightly leathery, upper surface dark green to blackish green, glossy, lower surface paler. Peduncle as petiole, 25–30 cm long, 3–8 mm in diam.; spathe triangular-ovate, 7.5–9 cm long, 3.5–4 cm wide, erect, acute, outside basal part purplish with darker venation, upper part whitish with purplish venation, inside base pale green with a distal purple zone or entirely dark purple, limb whitish, base inside moderately to strongly verrucate, warts shallowly elevated. Spadix shorter than spathe, sessile, 4.8–6.5 cm long; female zone cylindrical, 1–1.5 cm long, 0.7–0.8 cm in diam., flowers congested; male zone subcylindric, slightly widening to the apex, 2.7–3.4 cm long, 0.7–0.9 cm in diam., flowers congested; appendix short-conical, 1.4–1.9 cm long, 0.7–0.8 cm in diam., smooth, obtuse, white. Ovary ob-conical, depressed, upper part strongly truncate, 2 mm in diam., 1.5 cm high, green or pale green, unilocular; style nearly absent, 0.5 mm long, 1 mm in diam., pale green or pale purple; stigma depressed, entire, 1.5 cm in diam., 1 mm

high, verrucate. Male flowers consisting of 4–5 stamens; stamens 1 mm long; filaments 0.1–0.2 mm long, connate; anthers 0.8 mm long, 1 mm in diam, pores apical, fusing to form a common large pore per theca at male anthesis. Fruiting part short-elongate, berries congested; berry ovate, truncate, white, then turning pinkish purple and finally blue. Pollen striate.

Additional specimen examined—Type locality, from a plant cultivated in the Botanical Gardens of Wageningen University, (orig. coll. A. Galloway, type locality), *Hetterscheid HAM.1431* (WAG).

Distribution—Only known from the type locality.

Etymology—The species is named after Alan Galloway (USA) who has amassed a lot of observations on *Amorphoballus* plants in the field as well as on plants in his own long-standing collection. The observations made on Galloway's material have greatly improved the quality of the revision work done by the author.

Notes—The relatively short appendix compared to the male zone, is a feature found in *Amorphoballus* only in *A. koratensis* Gagn. and *A. napiger* Gagn. The differences however with those species are numerous and the similarity is obviously homoplasious. At this point there is no sound argument to suggest any alliance of *A. gallowayi* with known species groups in *Amorphoballus*.

4) *Amorphoballus glaucophyllus*

Hett. & Serebr. **sp. nov.** Type: collected from a plant cultivated in the Botanical Gardens of Wageningen University (orig. coll.: THAILAND, Kanchanaburi, "isolated table mountain near the Burmese border", Sappasiri Chaovanich s.n.), 3 July 2005, *Hetterscheid HAM.1400-T* (holotype, WAG, spirit collection.). Figures 10–13.

Ab *Amorphoballi* grex *Pseudodracontii* speciebus omnibus petiolo brevi, foliis crassissimis, stigmatibus maximis echinatis clare sulphureis (versus minori-



Fig. 10. *Amorpbopballus glaucophyllus* Hett. & Serebr. Leaf (upper view).

bus, tuberculatis, sublaevibus, eburneis) differt

Tuber subglobose to depressed globose, ca. 8 cm in diam., bright orangish brown, offset vegetative propagation unknown. Leaf solitary; petiole 12–15 cm long, 1–1.4 cm in diam., sturdy, smooth, semi-glossy, background colour pale olive green, with



Fig. 11. *Amorpbopballus glaucophyllus* Hett. & Serebr. Inflorescence (lateral view).



Fig. 12. *Amorpbopballus glaucophyllus* Hett. & Serebr. Spadix (fertile part).

numerous small or larger and then confluent, blackish green spots; lamina moderately dissected, anterior segment sometimes undivided, 30–40 cm wide, rachises unwinged; leaflets elliptical, 10–17 cm long, 4–7 cm wide, acute, leathery, upper surface bright pale grey-blue, lower surface bluish green. Inflorescence appearing a while after leaf maturation, longer than leaf; peduncle 35 cm long, 0.7 cm in diam., coloured as petiole but with additional small, scattered white spots; spathe cymbiform, triangular-ovate, slightly hooded, 12 cm long, 6 cm in diam., outside uniformly pale green, after female anthesis changing to whitish green, inside whitish green and at the base a short dark purple zone, base within very shallowly rugulose, apex sharply acute; spadix shorter than spathe, sessile, 8 cm long; female zone cylindrical, 6 mm long, 8 mm in diam., flowers congested; male zone cylindrical, 5 cm long, 1 cm in diam., flowers distant; appendix stipe 7 mm long, 4 mm in diam. at the



Fig. 13. *Amorphoballus glaucophyllus* Hett. & Serebr. Spadix (detail of base).

middle, appendix conical, 1.7 cm long, 0.9 cm in diam. at the base, apex obtuse, surface deeply corrugated separating rod-like papillae and short sinuous muri, off-white. Ovary depressed, 1.2 mm high, 2.2 mm in diam., off-white; style short and thick, 0.4 mm long, 1 mm in diam., off-white; stigma depressed, 1.5 mm in diam., 0.4 mm high, entire, strongly echinulate, bright pale yellow, unilocular; stamens consisting of 3–4(–5) stamens; stamens 2–2.5 mm long; filaments entirely or basally fused, column 1–1.5 mm long, 0.5–0.8 mm in diam., off-white; anthers free but in the lowermost flowers more or less laterally fused to form synandria, subglobose, ca. 1 mm in diam., off-white. Pollen striate with psilate polar caps.

Distribution—Only known from the scanty data of the type.

Etymology—The species epithet refers to the striking grey-blue upper surface of the leaflets.



Fig. 14. *Amorphoballus josefbogneri* Hett. Leaf (upper view).

Note—This new species has been given a name in the genus *Amorphoballus* although it is clearly a member of the species group presently known as the genus *Pseudodracontium* N.E. Br. However, compelling evidence from morphological as well as molecular analyses indicate beyond a doubt that the genus *Pseudodracontium* is strongly nested within *Amorphoballus*. This taxonomic decision and the necessary new combinations will be published by the author as part of the entire taxonomic revision of *Amorphoballus* (Hetterscheid, in prep.). In this light, it seemed superfluous to publish this new species in *Pseudodracontium*.

The bright yellow and strongly echinate stigmas are new to this group (*Pseudodracontium*-group) of *Amorphoballus*, as are the extremely bright bluish-grey leaflets.

5) *Amorphoballus josefbogneri* Hett.

sp. nov. Type: collected from a plant cultivated in the Botanical Gardens of Wageningen University (orig. coll.: THAILAND, Kanchanaburi Prov ince, on an unnamed table mountain near the Burmese border, Sappasiri Chaovanich s.n.), 24 June 2005, *Hetterscheid H.A.M.1396-T*, (WAG, holotype, WAG, spirit collection). Figures 14–16.

Hic folii coloribus texturaque, spatthae margine incurvo *A. saururi* grege valde pertinet, ab omnibus eis foliis textura maxime crassa petiole brevissimo differt. Hic character *A. pygmaeo* communicat, sed *A.*



Fig. 15. *Amorphophallus josefbogneri* Hett. Inflorescence.



Fig 16. *Amorphophallus josefbogneri* Hett. Spadix base (spathe cut open).

josefbogneri folii latere inferiore atropurpureo caret et quoque tuber multo longior tenuior.

Tuber narrowly elongate, branching, to 13 cm long, to 1.5 cm in diam., rhizomorphic, white. Petiole short, 8–9 cm long, 2–4 mm in diam. smooth, uniformly dull green to greyish-green; lamina to 19 cm in diam., few leaflets, rachises short, winged all over; leaflets elliptic to slightly elongate obovate, 5–10 cm long, 2–5 cm in diam., slightly leathery, apex acute, upper surface dark rich green with narrow purple margin, lower surface greyish-green. Peduncle 16 cm long, 6 mm in diam. at the base, smooth, lower part very pale brown grading upwards to uniformly pale green. Spathe cymbiform, ovate, 8 cm long, 6 cm wide, base and limb not separated, short and loosely convolute, apex acute, margins slightly concave, outside base pale green, grading upwards to off-white, apex pale greyish-green, inside

base pale green, grading upwards to whitish green, base within densely set with fleshy, irregularly elongate, verruculate warts. Spadix longer than spathe, 11 cm long; female zone cylindrical, 1 cm long, 7 mm in diam., flowers distant; male zone subcylindrical, slightly tapering to the apex, 3 cm long, 8 mm in diam., flowers congested; appendix narrowly elongate-conical, 7 cm long, 9 mm in diam., distinctly bent forward, base constricted, apex subacute, surface rugulose, off-white, emitting a strong scent of oligomethyl-oligosulphides at female anthesis. Ovary depressed, 2 mm in diam., 0.8–1 mm high, unilocular, pale green; style short, directed upwards at ca. 45 degrees, ca. 0.4 mm long, ca. 0.6 mm in diam., whitish green; stigma depressed, subtriangular to irregular in outline, weakly 2–3-lobed, 1–1.2 mm in diam., ca. 0.4 mm high, verruculate, off-white. Male flowers consisting of (2-)3–4(-5) stamens; stamens very short, 0.6 mm high, 2–3 mm in diam.; filaments almost



Fig. 17. *Amorphophallus laoticus* Hett. Inflorescence.



Fig. 18. *Amorphophallus laoticus* Hett. Spathe (lateral view).

absent, 0.1 mm, fused, off-white; anthers ca. 0.5 mm long, truncated, off-white, pores apical, slit-like.

Etymology—The species is named after my friend and greatest aroid scientist alive, Josef Bogner, Doctor Honoris Causa at the Munich Botanical Garden, now retired but never at rest.

Notes—*Amorphophallus josefbogneri* is obviously a member of the *A. pygmaeus* alliance, identified by the deep rich green leaves with narrow reddish-lilac margin, the concave white spathe with incurved margin. The very short-petioled, extremely thick-textured leaves are matched only by *A. pygmaeus* Hett. (C. and S. Thailand) itself but the latter has the lower surface of the leaves a rich deep reddish-purple and a much smaller tuber, which is either subglobose or only very shortly elongate.

6) *Amorphophallus laoticus* Hett., sp. nov. Type: LAOS (central), left bank of the Mekong River, *Harmand s.n.* (holotype, P). Figures 17–20.

Ab *A. piloso* stylis longis gracilibus, inter pistillos glaber differt, ac ab *A. konjac* spadice pilis dispersis, polline laevi.

Tuber elongate, thin, to ca. 30 cm long, ca. 3 cm in diam. Leaf solitary, petiole 55–80 cm long, 1–2 cm in diam., smooth but epidermal cells distinctly sharp conical providing the petiole with a satiny sheen and a slightly papery touch, background blackish grey or dark reddish brown with many scattered, irregular, pale grey spots and numerous tiny, pale grey dots; lamina 72–100 cm wide, rachises narrowly winged throughout; leaflets elliptic-lanceolate to lanceolate, narrowly acute, 14–20 cm long, 2–4 cm wide, upper surface deep velvety green with a broad grey zone along the midrib. Inflorescence solitary, long peduncled; peduncle 25–50 cm long, 1–1.8 cm in diam. as petiole; spathe broadly elongate triangular, acute, 10–33 cm long, 10–37 cm in diam., base and limb separated by a strong constriction, base outside pale green with scattered, linear, whitish spots, inside dark purple, limb



Fig. 19. *Amorphoballus laoticus* Hett. Spadix (spathe cut open).

oblique, strongly arching forward at male anthesis, outside along the centre strongly costate, colour as base but margins flushed dirty purple, inside dull dark purple, margin slightly undulate, base within strongly papillate-verrucate, verrucae often narrowly muricate or partly confluent and ridge-like. Spadix longer than spathe, sessile, 18–90 cm long; female zone cylindrical, 4 cm long, 1–3 cm in diam. (incl. styles), flowers slightly distant; male zone elongate, slightly fusiform, 2.5–7.5 cm long, 1–2.8 cm in diam., flowers congested, with or without scattered hair-like staminodes in between the functional flowers; appendix elongate fusiform-conic, acute, 10–79 cm long, 0.8–2.5 cm in diam., smooth or with scattered, hair-like staminodes, glossy dark purple. Ovary depressed, lower half sunken in pocket in spadix-axis, elliptical in cross-section, 1.5 (short axis)–3 (long

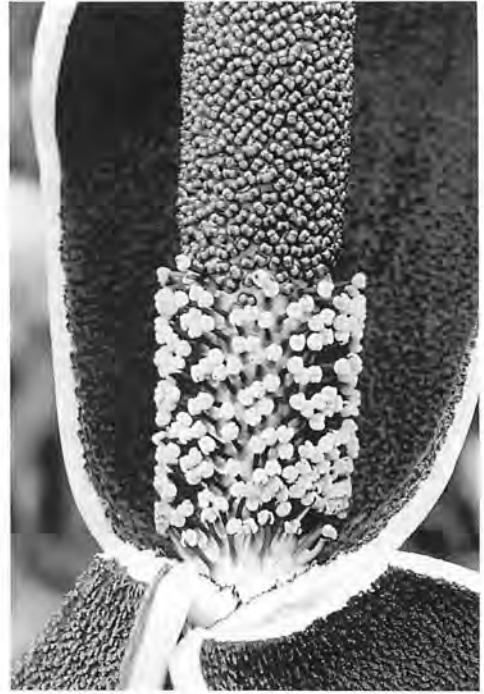


Fig. 20. *Amorphoballus laoticus* Hett. Spadix (detail of base).

axis) mm in diam., 2 mm high, base white or pale green, apex dark purple, bilocular; style long, thin, 3.5–4 mm long, 0.8–1 mm in diam., dark purple; stigma large, 2 mm in diam., 2 mm high, laterally depressed and apex depressed, very shallowly bilobed, lobes rounded, surface densely scabrate, white or dirty pale brown. Male flowers consisting of (2-)3–5 stamens; stamens 1.5 mm long; filaments 0.5 mm long, connate, whitish; anthers truncate, ca. 1.5 mm in diam., ca. 1 mm long, glossy dark purple, connective with a longitudinal groove. Staminodes hair-like, to ca. 1 cm long, dark purple. Inflorescence with fruiting part cylindrical, 15 cm long, 4 cm in diam., berries crowded. Berries globose or laterally depressed, ca. 1 cm long, 0.7–1 cm in diam., yellow. Pollen psilate.

Additional material studied—LAOS, Bokeo Province., Houaysai, Billensteiner s.d. (living plants cultivated in the Wageningen Botanical Gardens, spirit material from these Hetterscheid *H.A.M. 1011, 1012*



Fig. 21. *Amorphoballus lunatus* Hett. & M. Sizemore. Leaf (upper view).

and 1013, L); Laos, Champasak Prov., Khong Distr., Khon Island (Mekong river), base of Khon Hill, *Maxwell 98-517*(CMU).

Ecology—In partly open, disturbed margins of degraded, mixed evergreen and deciduous seasonal hardwood forest.

Etymology—The species epithet refers to Laos, where this species seems to be endemic.

Indigenous names—gah buk.

Notes—*Amorphoballus laoticus* bears a great similarity to *A. pilosus* Hett. from Vietnam but differs in having a long style (only 1 mm in *A. pilosus*) and having no hairs in the female zone (as opposed to numerous in *A. pilosus*), and *A. longicomus* Hett. & M. Serebr., which has a perfectly depressed-globose tuber. Other species with hairs on the spadix are *A. birtus* N.E. Brown (Taiwan; style thick, only 1 mm long), *A. kiussianus* (Makino) Makino (S. Japan, Taiwan & SE China; style near absent, hairs only on appendix, pollen striate-areolate), *A. henryi* N.E. Brown (Taiwan; peduncle short, hairs only on appendix) and *A. lanuginosus* Hett. (Vietnam; numerous hairs only in male zone, style only 0.5 mm).

7) *Amorphoballus lunatus* Hett. & M. Sizemore. **sp. nov.** Type: from a plant cultivated in the Botanical Gardens of Wageningen University (orig. coll. THAILAND, Kanchanaburi Province, road from Kanchanaburi to



Fig. 22. *Amorphoballus lunatus* Hett. & M. Sizemore. Inflorescence.

Thung Ri, "in medium shade in soil on right slope in secondary growth" M. Sizemore), 17 February 2004, *Hettterscheid H.AM.1358-T* (holotype, WAG, spirit collection). Figures 21–23.

Amorphoballo saururo similissimus, sed laminae multo minore divisae, stylus brevissimus. Etiam *A. sizemoreae* similis, sed in ovario biloculare nec uniloculare differt.

Tuber short elongate, rarely branching, to 8 cm long, to 3 cm in diam. Leaf solitary; petiole terete, 25–30 cm long, 7–8 mm in diam., uniformly pale reddish brown; lamina 17–20 cm in diam., main segments with few, relatively large leaflets, winged to the base. Leaflets elliptic-oblong, 6–11 cm long, 2.8–4.5 cm in diam., acute-acuminate, upper surface rich dark green, margin narrowly lined purplish-red, lower surface pale green, margin as upper surface. Inflorescence solitary; peduncle 20 cm long, 5 mm in diam., as petiole; spathe ovate, slightly concave, erect, 6 cm long,



Fig. 23. *Amorphoballus lunatus* Hett. & M. Sizemore. Spadix base (spathe cut open).

4 cm in diam. greenish white all over, margins involute, apex acute, base within densely clothed with short, fleshy, complexly-branched verrucae. Spadix sessile, longer than spathe, 11.5 cm.; female zone cylindrical, 0.5 cm long, 0.7 cm in diam., flowers adjacent, not densely congested; male zone cylindrical-conic, base slightly constricted, 3 cm long, 0.6 cm in diam. at the base, 0.5 cm at the apex, flowers congested; appendix 8 cm long, ca. 0.7 mm in diam., narrowly elongate conical, tapering from base to apex, laterally flattened, base slightly attenuate, apex narrowly obtuse, surface irregularly rugulose, pale yellowish green, emitting a strong smell of gas (oligomethyl-oligosulphides). Ovaries strongly depressed, 2.5–3 mm in diam., 1 mm high, pale green, bilocular; style 0.4 mm long, 1.5 mm in diam., white; stigma disciform, 2 mm in diam., 0.3 mm high, subtire to shallowly 4–5-lobed, grooves between lobes radiating from the centre, central depression slightly elongate, margin some-

times slightly notched and lobed-sinuous, surface minutely rugulose, white. Male flowers consisting of 2–5 stamens; stamens 1 mm high, 1–1.5 mm in diam., polygonal in cross-section; filaments ca. 0.5 mm long, fused, whitish; anthers ca. 0.5 mm long, truncated or slightly conical, pale greenish, pores apical, rounded or in the lowermost lunate to circular. Pollen striate.

Distribution—Thailand, Nakhon Sawan and Kanchanaburi Provinces.

Etymology—The species is named for the shape of the pores in the lower male flowers.

Additional specimens examined—From a plant cultivated in the Botanical Gardens of Wageningen University (orig. coll.: Thailand, Nakhon Sawan Province, Kho Nor., M. Sizemore), *Hetterscheid H.AM.1188* (WAG, spirit collection.); as previous, (orig. coll.: Thailand, Nakhon Sawan Province., Kho Nor), *Hetterscheid H.AM.1189* (WAG, spirit collection.).

Notes—The inflorescence of *A. lunatus* resembles that of *A. saururus* Hett. but the style is much shorter. From *A. sizemoreae* Hett., it differs in a much smaller inflorescence, smaller leaf and bilocular ovary (vs. unilocular). The typical shape of the pores in the lower male flowers is shared with *A. operculatus* Hett. & M. Sizemore.

8) *Amorphoballus myosuroides* Hett. & A. Galloway *sp. nov.* Type: from a plant cultivated by A. Galloway (orig. coll., LAOS, Khammouane Province, A. Galloway), 26 June 2005, *Galloway AGA-1756-01-T* (holotype, WAG, spirit collection.). Figures 24–27.

A congeneribus facile et unice distinctus in characteribus conijunctis: rhizoma breve repens, inflorescentiae usque ad 3 cum folio maturo variegato semi-radiato simultanee producentes, appendices longae tenues, flores masculi verticillati/helocoidei, baccae corrugatae virides.

Underground part a very short rhizome, ca. 2 cm long, ca. 1 cm in diam., annually producing some 10–15 offsets, these fusi-



Fig. 24. *Amorphoballus myosuroides* Hett. & A. Galloway. Short rhizome plus offsets. Photograph by A. Galloway.

form, 4 mm long. Leaf solitary; petiole 18–22 cm long, 3–4 mm in diam.; lamina with very short rachises resulting in a subradiate condition, 8–10 cm across, with usually 6 leaflets; leaflets elongate elliptic, 4–5 cm long, 1 cm wide, upper surface green with a distinct broad, pale grey feathering along the midrib, acute. Inflorescences up to 3 per season, appearing alongside the ma-



Fig. 25. *Amorphoballus myosuroides* Hett. & A. Galloway. Leaf (upper view). Photograph by A. Galloway.



Fig. 26. *Amorphoballus myosuroides* Hett. & A. Galloway. Inflorescence. Photograph by A. Galloway.

ture leaf, a few weeks after leaf development, each ca. 4 weeks apart; peduncle 16–22 cm long, 2–3 mm in diam.; spathe triangular-ovate, concave, fornicate, 4–5 cm long, 2.5–3 cm wide, outside white with a pale greenish lower half, inside white, base inside very shallowly verrucate with very few warts, apex acute. Spadix longer than spathe, sessile, 7.5–8.5 cm long; female zone cylindrical, 6–9 mm long, 5 mm in diam., flowers more or less congested; sterile zone above female zone naked, 2–4 mm long; male zone elongate cy-



Fig. 27. *Amorphoballus myosuroides* Hett. & A. Galloway. Spadix base (spathe cut open). Photograph by A. Galloway.

lindric-conic, 2–2.5 cm long, 4 mm in diam. at the base, 3 mm in diam. at the apex, flowers mostly distant, partly arranged in a spiral; appendix myosuroid, 4.7–5 cm long, 2–2.5 mm in diam., slightly but distinctly sinusoid, surface smooth, off-white, apex sharply acute. Ovary depressed, 2–3-lobed, 2 mm in diam., 1 mm high, unilocular, dirty green with dark purple spots or almost entirely dark purple; style short, 0.5 mm long, 0.5 mm in diam., dark violet-purple; stigma depressed, 0.7 mm in diam., 0.3 mm high, with a central depression, surface verrucate, dark purple. Male flowers consisting of 1–3 stamens; filaments absent; anthers fused within one flower, 1 mm high, 2–3 mm in diam., off-white, pores apical, rounded. Fruiting part slightly elongate, berries congested; berries obovate, truncate, ca. 5 mm long, ca.

4 mm in diam. at the apex, basal part white, upper part pale green, surface striate-verrucate. Seeds globose, ca. 3 mm in diam., pale green. Pollen striate.

Distribution—Only known from the type locality.

Etymology—The species epithet refers to the shape of the appendix.

Notes—For its leaf alone, *A. myosuroides* is unique in the genus *Amorphoballus* s.l. (incl. *Pseudodracontium*). The subradiate condition and the pale grey feathering along the midrib are the unique characters. The inflorescence of *A. myosuroides* resembles quite closely that of *A. barmandii* Engl. & Gehrm. from Vietnam. The multiple flowering behaviour is shared with *A. ongsakulii* Hett. & A. Galloway (this publication). The general appearance of spathe and spadix (incl. the thin appendix) are found to be exactly similar in both species. However, the few specimens known of *A. barmandii* show it to be leafless in the flowering stage and it has distinct filaments and the ovaries are 2–3-locular. The phylogenetic affinity of *A. myosuroides* may be to *A. barmandii* after all but the possession of a short creeping rhizome strongly indicates a closer affinity to *A. verticillatus* Hett., which also has quite strongly reduced rachises, and flowers after leaf development and has a subverticillate-spiralling arrangement of the male flowers.

The striate-verrucate surface of the largely green berries is shared with *A. sumawongii* (Bogn.) Bogn. and *A. polyanthus* Hett. & M. Sizemore.

9) *Amorphoballus ongsakulii* Hett. & A. Galloway **sp. nov.** Type: from a plant cultivated by A. Galloway (orig. coll.: LAOS, Khammouane Province, in heavy shade in soil pockets on boulders, *A. Ongsakul s.n.*), 29 July 2004, *Galloway AGA-1534-01-T* (holotype, WAG, spirit collection.). Figures 28–30.

Ab omnibus congeneribus cum tuberibus globosis in tubere minutissimo (tuber



Fig. 28. *Amorphoballus ongakulii* Hett. & A. Galloway. Leaf segment.

matura 2 cm diam. tantum), foliolis minimis (usque ad 11 mm longis) differt. Etiam inflorescentiae et folia maturata simultanei producens extans qui character in speciebus rhizomatis occurit et in solo species tuberosae sed multo maiore, *A. tuberculatus* infra descripsi.

Tuber globose, to 2 cm in diam., annually producing numerous (to ca. 15), fusi-



Fig. 29. *Amorphoballus ongakulii* Hett. & A. Galloway. Inflorescence.



Fig. 30. *Amorphoballus ongakulii* Hett. & A. Galloway. Spadix base (spathe cut open).

form offsets. Petiole 7–9 cm long, ca. 2 mm in diam., smooth, pale yellowish green to dirty greenish brown, with or without darker, thin stripes; lamina 13–16 cm in diam., rachises narrowly winged throughout; main segments highly dissected; leaflets very small, 3–11 mm long, 2–4 mm in diam., elliptic to lanceolate, apiculate, margin very finely, slightly irregularly serrate, upper surface dark green with distinct whitish midrib, lower surface paler. Flowering shortly after leaf maturation, sometimes flowering up to four times consecutively, with ca. 3–4 weeks separating each flowering. Peduncle smooth, 16 cm long, 2 mm in diam., base whitish gradually changing to very pale yellowish-brown; spathe elongate ovate, 34 mm long, 14 mm wide, erect, base tubular, loosely convolute, outside greyish-green with parallel dark greyish veins, inside dark purple, strongly verrucose, limb basal half auriculate, upper half pressed against

the appendix, apex acute, outside whitish with thin, pale green venation, slightly transparent. Spadix sessile, longer than spathe, 42 mm long, slightly curved forward; female part 2 mm long, 3 mm in diam., flowers slightly distant; male part elongate, slightly conical, 12 mm long, 3 mm in diam. at the base, 2 mm in diam. at the apex, flowers distant, less so in the upper part; appendix shortly stipitate (stipe 1 mm long, purple), 27 mm long, 2 mm in diam. at the base, 1 mm in diam. at the apex, narrowly elongate conical, base narrowed to the stipe, apex obtuse, surface smooth, pale yellowish-brown. Ovaries depressed, two-lobed, ca. 2 × 1 mm in diam., 0.8 mm high, base white, upper half pale purplish, bilocular, locules separated by two strong lateral constrictions of the ovary wall; style conical, 0.2 mm long, 0.4 mm in diam. at the base, pale green; stigma depressed, 0.8 mm in diam., 0.3 mm high, very shallowly bilobed, minutely echinate, pale green. Male flowers consisting of 2–3 stamens; stamens irregularly angulate in shape, truncate, 0.3–0.5 mm in diam., 0.2–0.3 mm high; filaments ca. 0.1 mm long, fused, whitish; anthers 0.1–0.4 mm high, reddish purple; pores apical, orbicular. Fruiting part more or less globose, berries crowded; berries ovate, truncate, ca. 6 mm in diam., ca. 4 mm long, deeply bilobed, contracted between the seed-containing locules, surface rugulose, pale green with whitish punctation, area around the style remnant dark greyish green, 2-seeded; seeds globose or subglobose, 2–3 mm in diam., greyish to dirty greenish.

Additional specimen examined—Type locality, from a plant cultivated in the Botanical Gardens of Wageningen University (orig. coll. Galloway), 24 May 2005, *Hettterscheid H.AM.1428* (WAG, spirit collection.).

Distribution—Only known from the type locality.

Etymology—The species is named after Annop Ongsakul (Thailand), who collected the first plants ever of this species, for

his friendship with the second author of this species' name and his extensive help in past field expeditions.

Notes—*Amorphoballus ongsakulii* is unique for its very small leaf, yet with a very high number of very small leaflets, giving the leaf a fern-like resemblance. Also the tuber is the smallest of all known species with globose tubers but by contrast the number of annual offsets is the highest of any species of *Amorphoballus*. And of all species with long peduncles, *A. ongsakulii* is no doubt the smallest. Another remarkable feature is the repeated flowering in one season, hitherto only known in *A. polyanthus* but in the latter species usually preceding leaf development. The possible phylogenetic relationship of *A. ongsakulii* to any known *Amorphoballus*-alliance remains obscure. The deep rich green upper surface of the leaflets resembles that condition as in the *A. pygmaeus*-alliance but that is where the comparison stops.

10) *Amorphoballus prolificus* Hett. & A. Galloway sp. nov. Type: from a plant cultivated in the Botanical Gardens of Wageningen University (orig. coll.: THAILAND, central, precise data unknown, A. Galloway), 30 June 2005, *Hettterscheid H.AM.1245-T* (holotype, WAG, spirit collection.). Figures 31–33.

Spatha margine incurvo *A. saururi* specierum grege (*A. operculatus*, *A. pygmaeus*, *A. saururus*, *A. vogelianus*, *tc.*) arte similis, sed a his in distributionis pollenis machina *A. brevispathi* foedere (*A. brevispathus*, *A. interruptus*, etc.) similis differt: ad anthesi staminis unius duae thecae vicinae pollen ejaculantes per porum singularem communem post connectivi tenuis herniam plenam. Autem harum specierum nullus spathae margo incurvatus habent.

Tuber globose, 2–3.5 cm in diam., 1.8–3 cm in height, smooth, pale to mid brown, producing annual, large, globose to fusiform offsets, these 1.5–2.2 cm in



Fig. 31. *Amorphophallus prolificus* Hett. & A. Galloway. Inflorescence.



Fig. 32. *Amorphophallus prolificus* Hett. & A. Galloway. Spadix (spathe cut open).

diam., 2.3–3 cm long, remaining attached to the main tuber. Petiole 15–35 cm long, 4–8 mm in diam., smooth, uniformly greyish purple or dirty dark olive-green; lamina 16–40 cm in diam., rachises winged distal from the basal branchings, segments moderately divided; leaflets obovate to elongate obovate or elongate-elliptic, 7–18 cm long, 4.3–7.5 cm in diam., apex acute, upper surface green. Peduncle 20 cm long, 0.5 cm in diam., smooth, uniformly dark greyish brown; spathe erect, not separated in base and limb, transversely elliptical, 5 cm long, 8 cm wide, apex hardly distinguishable, very broadly acute, margin strongly concave, outside white with a greenish flush, base slightly greener, inside pale green, base with a very indistinct very pale purplish flush, base within densely set with shallow, irregular warts. Spadix longer than spathe, sessile, 10.5 cm long; female zone cylindrical, 7 mm long, 8 mm in diam., flowers distant and in distinct pockets sunk in the spadix axis; male zone

cylindric, base slightly constricted, 3 cm long, 1 cm in diam., flowers congested but in the lower part slightly separated in smaller and larger multi-staminate groups; appendix elongate conical, 6.8 cm long, 13 mm in diam. near the base, basal part slightly laterally compressed, apex acute, surface smooth, very shallowly rugulose, emitting a strong smell of oligomethyl-oligosulphides. Ovary subglobose, 1.5 mm high, 1.8 mm in diam., unilocular, pale green; style short, 0.5 mm long, 1 mm in diam., pale green; stigma large, depressed, entire, 2–2.5 mm in diam., verrucate, white. Lower male flowers consisting of (2–)5– ca. 10 stamens, upper flowers seemingly consisting of ever more stamens and then turning into a continuous zone; stamens 1 mm long, 1 mm in diam.; filaments 1 mm long, off-white, free; anthers 0.8 mm long, truncated, off-white, pores apical and fused to form one central pore per anther. Pollen psilate.



Fig. 33. *Amorphoballus prolificus* Hett. & A. Galloway. Spadix base (spathe cut open). Photograph by A. Galloway.

Distribution—Only known from the type locality.

Etymology—The species epithet refers to the prolific vegetative way of multiplying of this species.

Notes—The tuber of *A. prolificus* is reminiscent of *A. brevispathus* Gagn., as is the leaf. It also shares the typical pollen-release mechanism of the *A. brevispathus-interruptus* alliance. The spathe is very reminiscent of species in the *A. saururus*-alliance. Both characters (tuber & leaf) are also similar in *A. atrorubens* Hett. & M. Sizemore.

11) *Amorphoballus reflexus* Hett. & A. Galloway, **sp. nov.** Type: from a plant in cultivation by A. Galloway (orig. coll: THAILAND, Khampaeng Phet Province, soil pockets in limestone, A. Galloway), 29 July 2005, *Galloway AGA-1069-01-T* (holotype,



Fig. 34. *Amorphoballus reflexus* Hett. & A. Galloway. Leaf (upper view). Photograph by A. Galloway.

WAG, spirit collection.). Figures 34–37.

Amorphoballi reflexi flores masculi synantheriati eis *Pseudodracontii* similes sed pro *Amorphoballo* s.s. ignoti. Ab omnibus *Pseudodracontii* speciebus spadice spatha multo longiore, appendice laevi differt.

Tuber elongate, thin, 10–24 cm long, 1–2 cm in diam., rarely branching. Petiole to 40 cm long, 5–7.5 mm in diam., smooth, uniformly rich burgundy red; leaflets elliptic to elliptic-obovate, 2–5 cm long, 1.5–4.5 cm wide, apex acute, upper surface mid green. Inflorescence solitary; peduncle as petiole, 19 cm long, 0.5 cm in diam.; spathe broadly ovate, 4 cm long, 5 cm in diam., at first erect, then the upper part moving a little away from the spadix at female anthesis and at male anthesis the lower half reflexing to a position at a right angle with the spadix-axis, pulling the upper part of the spathe further away from the spadix, outside white with a green flush, inside white, base inside densely verruculate; spadix much longer than spathe, 11.5–13 cm long; female zone cylindrical, 0.5–0.6 cm long, 0.6 cm in diam., flowers distant; male zone fusiform, 1.5 cm long, 0.9–1 cm in diam., flowers distant; appendix narrowly elongate fusiform, 9–



Fig. 35. *Amorphoballus reflexus* Hett. & A. Galloway. Inflorescence (lateral view). Photograph by A. Galloway.

11 cm long, 0.7–0.8 cm in diam. at the middle, base tapering, apex acute, surface smooth, off-white, creamish or pale green. Ovary depressed, oval in cross-section, sunken into the spadix-axis, 1.5–2 mm in diam., 0.8 cm high, slightly bilobed by two opposite, shallow peripheral constrictions, pale green, 2(-3?)-locular; style short, thick, 0.5 mm long, 1 mm in diam.; stigma very thin, 1 mm in diam., 0.1–0.2 mm thick, shallowly bilobed, verruculate, dirty creamish. Male flowers fully synstaminate, consisting of 3–5 fully fused stamens; filaments fused into a column, 1–2 mm long, 2 mm in diam. off-white; anthers fully



Fig. 36. *Amorphoballus reflexus* Hett. & A. Galloway. Spathe and spadix (lower part). Photograph by A. Galloway.

fused into a disc, 2.5–3 mm in diam., 1 mm high, with a shallow, elongate, central depression, pores lateral, slit-like; pollen few, released immediately after the reflexing of the spathe base and being dropped on its horizontal inner surface. Fruiting part elongate, berries crowded; berries ovate to lageniform, smooth, ca. 1 cm long, ca. 1 cm in diam., green when immature, then turning glossy white, 1- to 3-seeded. Seeds subglobose to globose, ca. 5 mm in diam., greenish to blackish.

Additional specimen examined—Type locality, from a plant cultivated in the Botanical gardens of Wageningen University (orig. coll. A. Galloway), 9 July 2005, *Hettterscheid H.AM.1429*.

Distribution—Only known from the type locality.

Etymology—The species epithet refers to the behavior of the spathe during anthesis.



Fig. 37. *Amorphoballus reflexus* Hett. & A. Galloway. Spadix base (spathe cut away).

Notes—Certainly the most remarkable feature of *A. reflexus* is the shape of the male flowers, that perfectly imitate those of *Pseudodracontium* species. All other characters are typical *Amorphoballus* s.str. (excl. *Pseudodracontium*). A suggestion of phylogenetic relationship to other *Amorphoballus*-groups is difficult at this point. The white lageniform berries are unique to the *A. saururus*-alliance but *A. reflexus* lacks the typical leaf characters of species of this group (dark, deep velvet-green upper leaf surface with narrow, purple-red margin and spathe margin strongly concave). The long thin appendix is as extreme as in e.g. *A. linearis* Gagn. (Thailand), *A. elatus* Ridl. (Pen. Thailand, West Malaysia), *A. lamuginosus* Hett. (East Central Vietnam) or *A. operculatus* Hett. & Sizemore (Thailand). The leaflets, being obovate-elliptic resemble those of the *pusillus*-alliance (incl. *A. sumawongii* (Bogn.) Bogn.).



Fig. 38. *Amorphoballus schmidtiae* Hett. & A. Galloway. Tuber (upper view). Photograph by A. Galloway.

12) *Amorphoballus schmidtiae* Hett. & A. Galloway **sp. nov.** Type: from a plant cultivated by A. Galloway (orig. coll. LAOS, Bolikhamaxay Province, A. Galloway), 29 July 2004, *Galloway AGA-1582-01-T* (holotype, WAG, spirit collection.). Figures 38–41.

Specierum numero similis spathis spadibusque similariter satis indifferentibus, e.g. *A. asterostigmate*, *A. cicatricifero*, *A. carneo*, *A. excentrico* et *A. napalensi*. Ab omnibus his speciebus propagulis carentibus, antherarum poris lateralibus significanter differt.

Tuber depressed-globose, pale brown, 8.5 cm in diam., 5 cm high. Petiole smooth, 50 cm long, 2.5 cm in diam., uniformly rich purplish red; lamina 100 cm wide, rachises winged distal from the basal branching-points; leaflets elongate elliptic, 3.5–23 cm long, 1.5–7 cm wide, long acute, the second inner collective vein strongly developed, upper surface rich dark green. Peduncle as petiole, 38–40 cm long, 1 cm in diam.; spathe triangular ovate, 13.5 cm long, 10 cm wide, erect, outside whitish with a pale purplish flush in the basal half, inside white, base inside near smooth, apex acute. Spadix shorter



Fig. 39. *Amorphoballus schmidtiae* Hett. & A. Galloway. Leaf segment.

than spathe, 8 cm long; female zone cylindrical, 1 cm long, 1.2 cm in diam., flowers congested; male zone subcylindrical, 2.7 cm long, 1.3 cm in diam. at the base, 1.1 cm at the apex, flowers congested; appendix elongate conical, 4.3 cm long, 1.1 cm in diam., smooth, obtuse, off-white. Ovary elongate, angulate, 1.5 mm long, 2 mm in diam., pale or mid green, upper part truncate, unilocular; style 1 mm long, 0.6 mm in diam., pale green; stigma depressed or slightly hemispheric, entire, 1 mm in diam., 0.8 mm high, strongly echinate, dirty whitish. Male flowers consisting of 3–5 stamens; stamens 3.5 mm long; filaments 2 mm long, partly fused, off-white; anthers 1.5 mm long, 1 mm in diam., truncate, off-white, connective large, pale green, pores lateral. Pollen striate.

Distribution—Only known from the type locality.

Etymology—The species is named after Petra Schmidt, a friend and colleague who



Fig. 40. *Amorphoballus schmidtiae* Hett. & A. Galloway. Inflorescence. Photograph by A. Galloway.

has done a lot for the aroid world in her capacity as a staff member at the Missouri Botanical Garden and as a grower at Plant Delights Nursery.

Additional specimen studied—Type locality, from a plant cultivated in the Botanical Gardens of Wageningen University (orig. coll. A. Galloway), *Hetterscheid HAM.1433*.

Notes—With spathe and spadix not showing any remarkable characters or modifications, *A. schmidtiae* has a morphological resemblance to such species as *A. carneus* Ridl., *A. excentricus* Hett., *A.*



Fig. 41. *Amorphophallus schmidiae* Hett. & A. Galloway. Spadix base (spathe cut open). Photograph by A. Galloway.

napalensis (Wall.) Bogner & Mayo, *A. cicatricifer* Hett., *A. asterostigmatus* Bogner & Hett., etc. Within this assemblage of species, *A. schmidiae* is the only one with lateral pores. Also the strongly developed second inner collective vein is unique. The rich purple-red petiole is shared with *A. cicatricifer* only.



Fig. 42. *Amorphophallus serrulatus* Hett. & A. Galloway. Leaf (upper view).



Fig. 43. *Amorphophallus serrulatus* Hett. & A. Galloway. Leaf margin showing serration.

13) *Amorphophallus serrulatus* Hett. & A. Galloway **sp. nov.** Type: from a plant in cultivation by A. Galloway (orig. coll. THAILAND, Tak Province, A. Galloway) *Galloway AGA-1500-01-T* (holotype, WAG, spirit collection.). Figures 42–45.



Fig. 44. *Amorphophallus serrulatus* Hett. & A. Galloway. Inflorescence. Photograph by A. Galloway.



Fig. 45. *Amorphoballus serrulatus* Hett. & A. Galloway. Spadix base (spathe cut open). Photograph by A. Galloway.

Amorphoballus serrulatus species secunda folii margine vere serrulato gaudet. Species altera *A. smithsonianus* est, quae tuberculum subglobosum ac multos diversitates ceteros habet. *Amorphoballus serrulatus* *A. obscurum* proximus, differt in laminae margine serrulato ut iam diceo, spathe constrictione una tantum, appendix multo breviora crassiora differt.

Tuberculum subglobosum to slightly elongate, 1.5–2 cm long, 1–2 cm in diam., not branching. Petiole thin, 12–18 cm long, 0.3–0.5 cm in diam., smooth, uniformly pale green; lamina subpedate, consisting of only 4–6 leaflets, ca. 15 cm wide, central main segment undivided, lateral segments with 2–3 leaflets; leaflets elliptic to obovate, 6–8 cm long, 3.5–4.8 cm wide, apex acute with a small mucronate tip, margins minutely crenate-serrulate, upper surface uniformly green or with a few small, orbicular, white spots. Peduncle 1 cm long, 3 mm in diam., entirely subterranean, smooth, white; spathe erect, convolute part slightly tapering to the apex, elliptic to elongate-elliptic, 2.5–3 cm long, ca. 2 cm in diam., outside pale pinkish or greyish with purplish veins, inside base dark purple, limb densely spotted whitish pink and dark purple or almost entirely dark purple, apex acute, upper limb margin often curved inwards and slightly rugulose on the outer surface, base inside smooth,

long convolute, basal part usually subterranean; spadix longer than spathe, sessile; female zone consisting of one whorl of flowers, 1 mm long, 3 mm in diam., flowers congested; male zone cylindrical, 2.5–3 mm long, 3 mm in diam., flowers congested or distant; appendix stipitate (stipe 0.5–1 mm long, 0.1 mm in diam., fusiform, 1.8–2.5 cm long, 2 mm in diam. (at the middle), acutish, surface lower part smooth, whitish or spotted purple and white, upper part rugulose, greyish, dirty creamish or spotted purple and white. Ovary subglobose, more or less 2-lobed, laterally flattened, 1–1.5 mm in diam., 1 mm high, white, spotted purple, bilocular; style oblique, elongate conical, 1 mm long, 0.5 mm in diam., at the base, 0.2 mm in diam. at the irregularly lobed apex, dirty greyish-whitish; stigma 0.1–0.2 mm in diam., very thin, lateral, more or less cup-shaped, sunk into the apical tissue of the style, circular or oval with a central depression. Male flowers consisting of 1–3 stamens; stamens 1–1.3 mm long; filaments ca. 0.3 mm long, connate; anthers 0.7–1 mm long, ca. 1 mm in diam., creamish. Pollen striate.

Distribution—Only known from the type locality.

Etymology—The species name refers to the serrulate margin of the leaflets.

Additional specimen examined—Type locality, from a plant cultivated in the Wageningen Botanical Gardens (orig. coll. A. Galloway), 6 August 2005, *Hetterschheid HAM.1430* (WAG, spirit collection).

Notes—*Amorphoballus serrulatus* is a member of the *A. pusillus*-alliance, a group of diminutive species with sessile inflorescences, which has shown to be monophyletic based on a number of molecular-phylogenetic analyses. From the species in this alliance (*A. pusillus* Hett. & Serebr., *A. obscurus* Hett. & M. Sizemore and *A. polyanthus* Hett. & M. Sizemore), *A. serrulatus* differs foremost by its serrulate leaf margins and additionally as follows: spathe not twice constricted as in *A. obscurus* and appendix much shorter and



Fig. 46. *Amorphophallus tuberculatus* Hett. & V.D. Nguyen. Leaf segment.

thicker; no staminodes as opposed to *A. pusillus*; a distinct style as opposed to *A. polyanthus*.

14) *Amorphophallus tuberculatus* Hett. & V.D. Nguyen **sp. nov.** Type: from a plant cultivated in the Botanical Gardens of Wageningen University (orig. coll.: NORTH VIETNAM,



Fig. 48. *Amorphophallus tuberculatus* Hett. & V.D. Nguyen. Inflorescence (lateral view).



Fig. 47. *Amorphophallus tuberculatus* Hett. & V.D. Nguyen. Inflorescence.

Quang Binh Province, Bo Trach District, Phong Nha –Ke Bang Natl. Park, Son Trach Community, “damaged secondary evergreen forest on a slope of a limestone mountain, alt. ca. 300 m.”, V.D. Nguyen *et al.* 214), 28 February 2005, *Hetterscheid HAM.1319-T* (holotype, WAG, spirit collection.). Figures 46–49.

Hic species unicus tubere globoso quo inflorescentia iuxta folium maturum moribundum crescet, statim folium mortuum floret. In pluribus characteribus ceteris *A. yunnannensis* gregem proximus ut videtur spatham spadicisque proprietates, odorem iucundum partirentes. Pro *A. tuberculato* unicus tuber verrucis magnis bacilliformibus carneis nullo modo radicum cicatricibus associatis.

Tuber depressed globose, ca. 10 cm in diam., ca. 8 cm high, densely covered with thick, short elongate protrusions, not as-



Fig. 49. *Amorphoballus tuberculatus* Hett. & V.D. Nguyen. Spadix, lower half (spathe cut open).

sociated with root-scars. Petiole 50 cm long, 2.5 cm in diam. smooth, somewhat succulent, pale brown with faint, elliptical, paler spots; lamina 120 cm in diam., highly dissected, rachises winged distal from the basal branchings, most proximal supernumerary leaflets very short petiolulate; leaflets closely set, elliptical to elongate elliptical, 3–25 cm long, 1.5–7 cm in diam., acuminate. Inflorescence appearing during leaf breakdown and maturing shortly after that; longest cataphyll 17 cm long, pale pink and white; peduncle 20 cm long, 1.8 cm in diam. smooth, dark purplish brown with scattered greyish brown, elliptical spots; spathe broader than long, triangular-ovate, 9 cm long, 13 cm in diam., strongly convolute, limb and base not separated, margin slightly revolute, apex acute, outside white with pale pinkish flushed veins and a pinkish flush near the base, inside white, base inside smooth; spadix sessile, longer than spathe, 15.5 cm

long; female zone subcylindric, dorsiventrally compressed, apex slightly expanded, 3 cm long, 2.3×1.8 cm in diam., at the base, 2.5×1.6 cm in diam. at the apex, flowers congested or contiguous; male zone urceolate, strongly dorsiventrally compressed, apex slightly dilated, base constricted, 3 cm long, 2.5×2.2 cm in diameter at the base, 4.3×2.5 cm in diam. close to the apex, flowers congested; appendix shortly and broadly conical, base slightly dorsiventrally compressed, apex slightly laterally compressed, 8.5 cm long, 5 cm in diam. just above the base, tapering to the apex, surface smooth with a few irregular shallow depressions, off-white, producing a clear candy-like smell (organic acetates). Ovary globose to ovoid, 2.5 mm long and 2–2.5 mm long, unilocular, pink; style very short, 0.5 mm long, 1.2 mm in diam., off-white; stigma depressed, 1.5 mm in diam., 0.5 mm high, minutely echinate, off-white. Male flowers consisting of 3–4 stamens; stamens 1 mm long; filaments 0.5 mm long, entirely fused, off-white; anthers 0.5 mm long, 1–1.5 mm in diam., truncate, off-white, pores apical, elliptical. Pollen striate.

Distribution—Only known from the type locality.

Etymology—The species epithet refers to the surface of the tuber.

Notes—*Amorphoballus tuberculatus* would seem to be a member of a group of species around *A. yunnanensis* (see below), all characterized by the scent of organic acetates (fresh, candy-like). However, the flowering behaviour of *A. tuberculatus* markedly differs from all these species, as does the tuber with its unique, long, fleshy warts. In fact it differs from almost all *Amorphoballus* in flowering behaviour, which comes closest to the behaviour of *A. ochroleucus*, although this species flowers alongside the leaf, just before the leaf-cycle terminates and has a conspicuous zone of staminodes between the female and male zones on the spadix. It is remarkable that several species of *Amorphoballus* in different suggested

clades, in the region N. Vietnam–Laos–S. China, show a deviating flowering cycle from other Asian species. *Amorphoballus coetaneus*, *A. bayi*, *A. rhizomatosus* and *A. verticillatus* all flower alongside the leaf long before the leaf dies down. In *A. ochroleucus*, the flower develops and matures when the leaf is close to its termination.

From all species in the *yunnanensis*-alliance, *A. tuberculatus* differs in having a strongly tuberculate tuber, the spadix distinctly longer than the spathe and its nearly all-white colour. The unilocular ovaries are shared in this group with *A. thaiensis* only.

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