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Taxonomic studies of *Araceae* in Myanmar IV: A new species, a new record and a new synonym for the genus *Amorphophallus*

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Key words

Aroideae
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Abstract *Amorphophallus wasa* Naive, K.Z.Hein & Hett., is described and illustrated as a species new to science from the Sagaing Region, Myanmar. It is morphologically similar to *A. saraburiensis* Gagnep., but can be easily distinguished by its unilocular ovaries and lack of staminodes between pistillate and staminate zones. A detailed description, colour plates, phenology, distribution map, provisional conservation status and a key to the *Amorphophallus* species from Myanmar are provided. In addition, *A. elatus* Hook.f. is reported as a newly recorded species for Myanmar, and the name *A. corrugatus* N.E.Br. is newly synonymized under *A. kachinensis* Engl. & Gehrm.

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INTRODUCTION

The genus *Amorphophallus* Blume ex Decne. (*Araceae*: *Thomosoniae*), is represented by over 200 species distributed in Asia, Africa, Madagascar, the Malay Archipelago, Australia and Melanesia (Magtoto et al. 2013, Nguyen et al. 2016, Gadpayale et al. 2017). Most of the species grow in tropical humid forests, seasonal forests, and grass savannahs, often on slopes, in forest margins, as well as secondary forest. Within *Araceae-Aroideae*, *Amorphophallus* is the only genus with the leaf parts having an involute margin during development from the bud. According to Li & Hetterscheid (2010) the genus can be recognized by usually having commonly solitary, usually decompound and very rarely subpedate, but never entire leaves and berries ripening red or blue.

In Myanmar, the genus is represented by 14 species of which four are considered to be endemic (viz. *A. angustispathus* Hett., *A. chlorospathus* Kurz ex Hook.f., *A. gliruroides* Engl. and *A. purpurascens* Kurz ex Hook.f.) (POWO 2021). In the last decade, new species of *Amorphophallus* have been discovered in India (Gadpayale et al. 2017), Laos (Nguyen et al. 2018), the Philippines (Hetterscheid 2012, Magtoto et al. 2013, Hetterscheid et al. 2020), Vietnam (Gong & Li 2012, Nguyen et al. 2016) and more discoveries can be expected, indicating that the diversity of *Amorphophallus* in Asia has not yet been fully revealed.

In a recent botanical exploration by the second author, conducted in the Sagaing Region of Myanmar an enigmatic *Amorphophallus* species was collected in Monywa District and Yinmabin District in June 2021. Detailed morphological examination and comparison with the relevant literature and actual and digitized type specimens of the genus *Amorphophallus* from Myanmar and neighbouring countries revealed that the collected specimen does not match any other known *Amorphophallus* species. Thus, we describe and illustrate it as *Amorphophallus wasa*, a species new to science and the 15th representative of the genus in Myanmar. Furthermore, we report the first record of *Amorphophallus elatus* in Myanmar collected in Myeik District of Tanintharyi Region and we discuss the synonymy of *A. corrugatus* and *A. kachinensis*, with the name *A. kachinensis* taking priority.

MATERIALS AND METHODS

The measurements and description of the species were based on examination of photographic images of plants *in situ*, living specimens, with general plant descriptive terminology following Beentje (2016). All relevant type specimens and literature of *Amorphophallus* species from Myanmar and neighbouring countries were examined in various herbaria via high resolution images accessed at https://plants.jstor.org/ and the Global Biodiversity Information Facility (GBIF) accessed from https://www.gbif.org.

An informal conservation status category was assessed by range size (B criterion), following IUCN Standards and Petitions Subcommittee (2019) recommendations. The extent of occurrence (EOO) and area of occupancy (AOO) were estimated using GeoCAT (Bachman et al. 2011).

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SYSTEMATICS

New species

Amorphophallus wasa Naive, K.Z.Hein & Hett., *sp. nov.* — Fig. 1, 2; Map 1

Amorphophallus wasa is similar to *Amorphophallus saraburiensis* Gagnep. from Thailand, but differs by lacking staminodes between pistillate and staminate zones, having a shorter, 0.7 mm long, brownish green style (vs style 1–2 mm long, purple), a unilocular ovary (vs bilocular ovary), an acute and rugulose appendix (vs obtuse and corrugate appendix), and spathe base inside with shallow warts (vs thick shortly elongate, fleshy warts). — Type: *K.Z. Hein 043* (holo KKU; iso KKU, TTM), Myanmar, Sagaing Region, Yinmabin District, Yinmabin Township, near Shwe Taung Oo Pagoda, elev. 40 m, N22°12'00" E95°04'10", 11 June 2021.

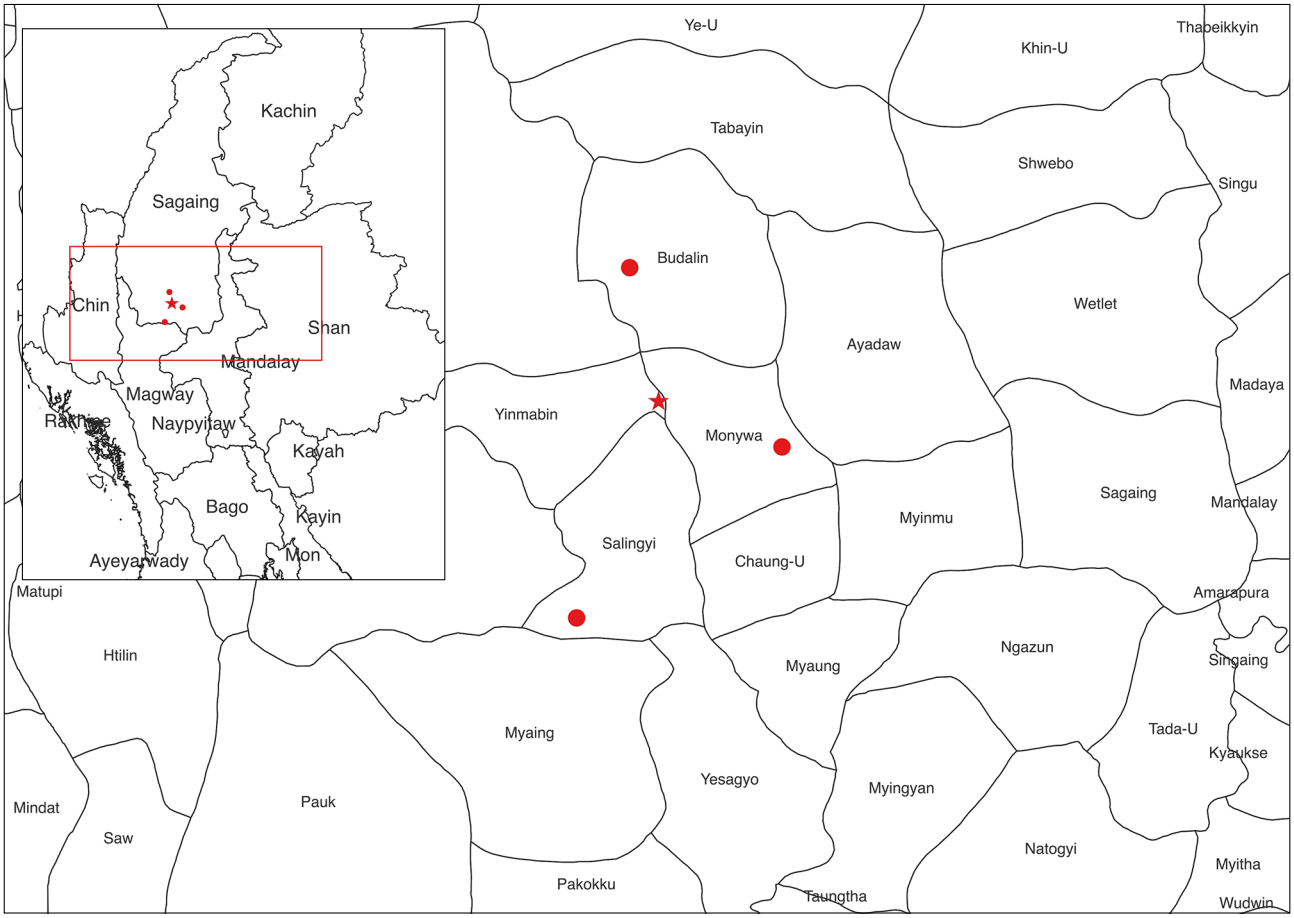
Etymology. The specific epithet '*wasa*' is coined from the species local name and used as a noun in apposition.

Seasonally dormant herb. *Tuber* napiform, 8.5–11 cm long by 4–10 cm diam, brown outside, white inside. *Leaf* solitary; *petiole*

Fig. 1 *Amorphophallus wasa* Naive, K.Z.Hein & Hett. a. Habit; b. leaf; c. inflorescence; d. infructescence. — Scale bars: c = 5 cm; d = 2 cm. — Photos: a, b, d: K.Z. Hein; c: Thuta Oo.

63–77 cm long by 2.1–3.3 cm diam at the base, 1.3–1.9 cm diam at the apex, smooth, terete, green to brownish purplish green with dark brown-olive spots; *lamina* decompound, 68–70 cm across, divided into 3 main segments, rachises narrowly winged throughout; *leaflets* elliptic to obovate, 4.3–11.5 cm long by 3–5.2 cm wide, apex acuminate, with an 0.2–1.2 cm long acumen, base asymmetric and decurrent, adaxially pale green, abaxially green, both surfaces glabrous. *Inflorescence* solitary, cataphyll 10–35 cm long; *peduncle* 58–84 cm long by c. 1.2 cm diam at the base, smooth, terete, green to brownish purplish green with dark brown-olive spots. *Spathe* (narrowly) triangular-ovate, 15–30 cm long by 4.5–6 cm diam; *base* shortly convolute, nearly entirely open, inside light green, with shallow warts, green with olive spots, margin entire, dark purple; *limb* usually erect, recurved when old, inside dark purple with green streaks at the centre, outside paler dark purple with brownish green streaks and olive-green spots, apex acute. *Spadix* longer than spathe, 21–40 cm long, stipitate; stipe c. 0.6 cm long, c. 0.8 cm diam, smooth, green; *pistillate zone* cylindric, 2–2.5 cm long, 1.2–1.5 cm diam, flowers slightly dis-

Fig. 2 *Amorphophallus wasa* Naive, K.Z.Hein & Hett. a. Inflorescence; b. spadix (inset: b1: pistillate flowers, b2: staminatee flowers); c. spathe. — Scale bars: a, c = 10 cm; b = 5 cm. — Photos: K.Z. Hein.



Map 1 Map of northern Myanmar (inset) showing the distribution of *Amorphophallus wasa* sp. nov. (●) with the locality of the type indicated by ★.

tant; *staminate zone* contiguous with pistillate zone, cylindric, 5–8.5 cm long, 1.1–1.5 cm diam, flowers congested; *appendix* contiguous with staminate zone, subulate, 14–32 cm long, 0.6–1.1 cm diam at the base, tapering, rugulose, coppery or claret, apex acute. *Ovary* globose to subglobose, c. 2 by 2 mm, unilocular, green; style cylindrical, c. 0.7 mm long, c. 0.8 mm diam, brownish green; stigma hemispheric, c. 1.3 mm high, c. 1.7 mm diam, bi- or trilobed, surface echinulate, yellow. *Staminate flowers* consisting of 2–4 stamens, slightly enlarged in the lowermost part of staminate zone; *stamen* c. 1.3 mm long, 1.5–2 mm diam; *filaments* c. 0.5 mm long; anther c. 0.7 mm long, c. 0.5 mm diam, yellow, connective yellow or purplish yellow, pore apical. *Infructescence* elongate; *berries* subglobose, c. 0.6 cm diam, green when young, red when ripe.

Distribution — This species is currently known from the Monywa District and Yinmabin District of the Sagaing Region, Myanmar.

Habitat & Ecology — The species grows in tropical dry forest, in a shaded and brightly lit environment at an elevation of 40–50 m a.s.l. Observed flowering in the wild from May to June and fruiting from July to August.

Conservation status — The extent of occurrence of *A. wasa* is 970.861 km^2 with an area of occupancy estimated to be 16 km^2 (calculated in GeoCAT with 2 km defined cell-width; Bachman et al. 2011), which complies with subcriterion ‘a’ of the Endangered category B2. With the distribution currently limited to areas within the Yinmabin and Monywa Districts, we herein propose this species to be treated as ‘Endangered’ (EN B2ab(iii)) following the Red List criteria of the IUCN Standards and Petitions Subcommittee (2019).

Vernacular name — Locally known by the Burmese people as wasa (ဝသာ).

Uses — The young inflorescences are cooked and eaten as a vegetable by local people.

Table 1 Morphological comparison of *Amorphophallus wasa* sp. nov. and similar species, *A. saraburiensis* Gagnep. (Gagnepain 1941), *A. scutatus* Hett. & T.C.Chapm. (Hetterscheid & Chapman 2001) and *A. tenuistylis* Hett. (Hetterscheid 1994).

Characters	*A. wasa*	*A. saraburiensis*	*A. scutatus*	*A. tenuistylis*
Spathe	triangular-ovate, base shortly convolute	triangular-ovate or elongate-triangular, base strongly convolute	triangular to lanceolate, base strongly convolute	elliptic-lanceolate to elongate-triangular, base strongly convolute
Warts in the spathe-base	short	elongate	elongate	elongate
Staminodes between pistillate and staminate zones	absent	present	present	present or absent
Ovary	unilocular	bilocular	unilocular	trilocular
Style	c. 0.7 mm long	1–2 mm long	3–4 mm long	3–4 mm long
Appendix	rugulose, apex acute	corrugate, apex obtuse	rugulose, apex obtuse	verrucose, apex acute

Notes — *Amorphophallus wasa* is considered to belong to a small clade of 3 species (*A. saraburiensis*, *A. scutatus* Hett. & T.C.Chapm. and *A. tenuistylis* Hett.). This strongly supported clade was recovered in an extensive molecular phylogenetic analysis by Claudel et al. (2017) and belongs to *A.* subg. *Scutandrium* Hett. & Claudel. More detailed comparisons between the morphologically similar species are presented in Table 1, and an identification key to the *Amorphophallus* species of Myanmar is provided below.

A NEW AMORPHOPHALLUS RECORD FOR MYANMAR

Amorphophallus elatus Hook.f.

Amorphophallus elatus Hook.f. (1893) 517. — Type: *H. Kunstler 2172* (holo CAL [CAL0000001413-image!]; iso K [K000291439-image!]), Peninsular Malaysia, Laurt, Perak, elev. 30–701 m, Aug. 1881.

Distribution & Habitat — Myanmar, Thailand and Peninsular Malaysia. The species is found growing in the field of young rubber plantations in Myanmar at 31 m a.s.l. In Thailand the species was found in dry, evergreen forest or mixed deciduous forest on granite or limestone at 75–100 m a.s.l. and in open jungle on rich soil in Peninsular Malaysia at 30–701 m a.s.l.

Specimen examined. Myanmar, Tanintharyi Region, Myeik District, Palaw Township, on route from Palaw to Myeik, c. 17 km SE of Topo, elev. 31 m, N12°45'38.5" E98°45'37.86", 4 June 2016, *N. Tanaka, A. Naiki, S. Tagane & Mu Mu Aung MY253* (TNS [TNS01280879-image!]).

A NEW SYNONYMY OF THE NAME AMORPHOPHALLUS CORRUGATUS

Amorphophallus kachinensis Engl. & Gehrm.

Amorphophallus kachinensis Engl. & Gehrm. in Engl. (1911) 91. — Type: *Shaik Mokim s.n.* (holo CAL [CAL0000001398-image!]), Myanmar, Kachin Hills, 20 May 1898.

Amorphophallus corrugatus N.E.Br. (1912) 269. — Type: *A.F.G. Kerr 1105* (holo K [K000291454-image!]), Thailand, Chiengmai, Doi Sootep, 1500 m, *syn. nov.*

Amorphophallus bannanensis H.Li (1988) 209, pl. 1 (1–8). — Type: *Li Heng 1106* (holo KUN), China, Yunnan prov., Menhai Xian, elev.1100 m, 1 Apr. 1986.

Thomsonia sutepensis S.Y.Hu (1968) 443, pl. 6 (f. 26–34); Bogner (1976) 19. — Type: *Sørensen, Larsen & Hansen FOT 2612* (holo C, spirit coll.; iso A), Thailand, Chiengmai, Payap, Doi Sutep, alt. 1100 m, 7 Apr. 1958.

Fig. 3 *Amorphophallus kachinensis* 'morphing' to '*A. corrugatus*' a. Typical appendix of *A. kachinensis* s.str.; b. appendix with furrows and a few convolutions at the top of the ridges; c. appendix with furrows and more convolutions than in e; d. appendix with furrows and many convolutions (ridges brain like); e. appendix with only shallow furrows, otherwise brain-like; f. appendix all brain-like, typical of '*A. corrugatus*'. — Photos: a, c: Y.J. Tao; b: D. Borah; d: W. Hetterscheid; e: C.I. Peng; f: A. Galloway.

Notes — In the *Araceae* treatment in Flora of Thailand (Hetterscheid 2012) and Flora of China (Li & Hetterscheid 2010), *A. corrugatus* was still recognized as a proper species. However, the third author of the present paper now proposes that the names *A. corrugatus* and *A. kachinensis* represent one and the same species, based on a new insight regarding the one character that was believed to differ enough in both species to accept their separate species status. Recent observations and a re-evaluation of this character (the surface structure of the appendix) lead the third author to conclude that his earlier opinion must now be abandoned in favour of considering *A. corrugatus* to be a redescription of *A. kachinensis*, the last name being the priorable one. The most relevant observations leading to the new conclusion is seen in a series of photographs (Fig. 3) showing all intermediate stages between the typical, brain-like convolutions of the appendix surface of *A. corrugatus*, to the few, vertical, deep fissures of the appendix surface of *A. kachinensis* s.str.

KEY TO THE GENUS AMORPHOPHALLUS OF MYANMAR (EXCLUDING A. CHLOROSPATHUS, A. GLIRUROIDES AND A. PURPURASCENS)

Due to the lack of enough detail mainly because of their incomplete and brief description in the protologues, we excluded three species in the key which are *A. chlorospathus*, *A. gliruroides* and *A. purpurascens*.

1. Spadix without appendix, sterile zone between staminate and pistillate zones present and set with large, globose or elongate obovoid staminodes . . . . . *A. margaritifer*
1. Spadix with appendix 2
2. Sterile zone between staminate and pistillate zones present, set with flattened, gibbous staminodes . . *A. krausei*
2. Staminate and pistillate zones contiguous, sterile zone absent 3
3. Peduncle much shorter than spathe, inflorescence usually sessile on the ground 4
3. Peduncle distinctly longer than spathe 6
4. Spathe campanulate, appendix very broadly conical, usually strongly wrinkled/folded, style long, narrow, to 4 mm long . . . . . *A. paeoniifolius*
4. Spathe oval, erect, appendix narrowly conical or narrowly fusiform, style c. 1 mm long 5
5. Peduncle dark green with white spots or lines, stigma large, to 4 mm diam . . . . . *A. bulbifer*
5. Peduncle uniformly dark or pale green, stigma to 2.5 mm diam . . . . . *A. yuloensis*
6. Spathe with a distinct base and limb, separated by a shallow or more distinct constriction, limb oblique or horizontal . . . . . *A. muelleri*
6. Spathe without constriction, limb erect 7
7. Spathe strongly concave 8
7. Spathe not concave 9
8. Appendix with a strongly convoluted surface (brain-like) or with two or more deep vertical furrow . . . *A. kachinensis*
8. Appendix not convoluted or furrowed, with shallow depressions . . . . . *A. putii*
9. Appendix diameter distinctly less than staminate zone diameter . . . . . *A. wasa*
9. Appendix diameter as staminate zone or broader 10
10. Stigma large, to 4 mm diam, spathe inside usually uniformly pale to deep pink . . . . . *A. bulbifer*
10. Stigma 1–2 mm diam, spathe inside never uniformly pale or deep pink 11
11. Staminate flowers not congested, slightly distant, appendix smooth . . . . . *A. angustipathus*
11. Staminate flowers strongly congested, appendix smooth or with several, scattered short hairs 12
12. Spathe base inside with several scattered, small verrucae . . . . . *A. elatus*
12. Spathe base within smooth or only very few minute verrucae . . . . . *A. cruddasianus*

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