



Phylogeny of *Amorphophallus* (Araceae) on Borneo with notes on the floral biology of three species

Sin Yeng WONG^{1,2,*}, Abd Rahim NOR FATHIAH¹, Wilbert HETTERSCHIED³

1. Institute of Biodiversity and Environmental Conservation, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia. 2. Research Associate, Harvard University Herbaria, 22 Divinity Avenue, Cambridge, MA 02138, U.S.A. 3. Von Gimborn Arboretum, Velperengh 13, 3941 BZ Doorn, The Netherlands. *Corresponding author's email: sywong@unimas.my

(Manuscript received 9 September 2021; Accepted 12 December 2021; Online published 9 January 2022)

ABSTRACT: This study was undertaken on *Amorphophallus* of Borneo to address two questions: (1) to determine the phylogenetic relations among taxa of Bornean *Amorphophallus* and (2) to investigate the floral biology and floral visitors of three *Amorphophallus* species. Phylogenetic analyses were carried out by using one plastid region: *matK*, and two nuclear regions: ITS and *PhyC*, with a total of 98 accessions representing 56 taxa of *Amorphophallus*. Floral biology of three *Amorphophallus* species (*A. hewittii*, *A. eburneus*, and *A. julaiihii*) were investigated. Bornean *Amorphophallus* is separated into three groups within subgen. *Amorphophallus*: *A. angulatus* and *A. pendulus* of the Paeoniifolius-Manta clade, *A. ranchanensis* as sister taxon to clade A, clade Pusillus II, and clade B. The anthesis of *A. hewittii* and *A. eburneus* lasted for ca. 49 hours and ca. 64 hours respectively. The pistillate anthesis was much longer in *A. hewittii* (36 hours) than *A. eburneus* (24 hours) but the staminate anthesis was much shorter in *A. hewittii* (13 hours) than *A. eburneus* (40 hours). Floral visitors to *A. hewittii* are different to those visiting *A. eburneus* and *A. julaiihii*; the latter two species attract less visitors and belong to clade A where hitherto no species has been investigated.

KEY WORDS: *Amorphophallus eburneus*, *Amorphophallus hewittii*, *Amorphophallus julaiihii*, Sarawak.

INTRODUCTION

Amorphophallus Blume ex Decne. the sole accepted genus of tribe Thomsonieae (Araceae) has approximately 220 species (Boyce and Croat, 2011 onwards). *Amorphophallus* comprises mainly lowland plants, growing in the tropical and subtropical zones of the Paleotropics from West Africa to the Pacific Islands and Japan (Mayo *et al.*, 1997) with the centre of diversity in IndoMalaya (Boyce and Croat, 2011). Borneo has 19 indigenous species, all are endemic. Ten species occur in Sarawak: *A. angulatus* Hett. & A. Vogel, *A. brachyphyllus* Hett., *A. eburneus* Bogner, *A. hewittii* Alderw., *A. infundibuliformis* Hett., A. Dearden & A. Vogel, *A. julaiihii* Ipor, Tawan & P.C. Boyce, *A. juliae* P.C. Boyce & Hett., *A. niahensis* P.C. Boyce & Hett., *A. pendulus* Bogner & Mayo, and *A. ranchanensis* Ipor, A. Simon & Meekiong and four species in Sabah: *A. lambii* Mayo & Widjaja, *A. rugosus* Hett. & A.L. Lamb, *A. tinekeae* Hett. & A. Vogel, and *A. venustus* Hett., A. Hay & J. Mood. One species, *A. hottae* Bogner & Hett. occurs in Sarawak and Sabah (Boyce *et al.*, 2010; Ipor *et al.*, 2012). *Amorphophallus borneensis* (Engl.) Engl. & Gehrm., *A. costatus* Hett., *A. linguiformis* Hett., and *A. suwidjanus* Ipor, Tawan & Meekiong are known only from Kalimantan.

Amorphophallus is supported as a monophyletic with the inclusion *Pseudodracontium* N.E. Br. (Hetterscheid and Claudel, 2012; Claudel *et al.*, 2017). The first analyses of species-level relationships in *Amorphophallus* were based on limited sampling (ca. 30% of species diversity) (Grob *et al.*, 2002, 2004;

Sedayu *et al.*, 2010) and revealed a small number of well-supported clades, among which the relationships were unresolved. Claudel *et al.* (2017) expanded the taxonomic sampling to include 70% of the known species using nuclear (ITS1) and plastid (*rbcL* and *matK*) gene regions. Their analyses resolved four clades treated as subgenera: *Amorphophallus*, *Metandrium* Stapf, *Scutandrium* Hett. & Claudel, and *Afrophallus* Hett. & Claudel. Subgenus *Amorphophallus* is also termed as the South East Asia (SEA) clade and comprises taxa distributed from India eastwards via continental South East Asia and Indonesia to the Philippines and Australia (Claudel *et al.*, 2017).

The pollination biology of *Amorphophallus* is hitherto known from a few field observations (van der Pijl, 1937; Bogner, 1976; Sivadasan and Sabu, 1991; Beath, 1996; Hetterscheid and Ittenbach, 1996; Singh and Gadgil, 1996; Punekar and Kumaran, 2010; Moretto *et al.*, 2019; Tang *et al.*, 2020) and have confirmed pollinators as: beetles (Cetoniidae, Nitidulidae, Scarabaeidae, Silphidae, and Staphylinidae), dung flies (Platystomatidae), and bees (*Trigona*). Apart from these pollinators, *Amorphophallus* species are also visited by beetles (Bostrichidae, Brentidae, Histeridae, Hybosoridae, Lyctidae, Rutelinae), flies (Calliphoridae, Drosophilidae, Muscidae), ants (Formicidae, Dolichoderinae), cockroaches (Blaberidae/Panesthiinae), and spiders (Sivadasan and Sabu, 1991; Hetterscheid, 1995; Hetterscheid and Ittenbach, 1996; Giordano, 1999; Punekar and Kumaran, 2010).

There are 19 indigenous *Amorphophallus* occurring on Borneo and to date, there is yet a study involving the inclusion of these taxa into a phylogeny which will serve