A new species of *Goniothalamus* (Annonaceae) from Palawan, and a new nomenclatural combination in the genus from Fiji

Chin Cheung Tang¹, Bine Xue¹, Richard M.K. Saunders¹

¹ School of Biological Sciences, The University of Hong Kong, Pokfulam Road, Hong Kong, P. R. China

Corresponding author: Richard M.K. Saunders (saunders@hku.hk)

Academic editor: T. Couvreur | Received 21 November 2013 | Accepted 13 December 2013 | Published 18 December 2013

Citation: Tang CC, Xue B, Saunders RMK (2013) A new species of *Goniothalamus* (Annonaceae) from Palawan, and a new nomenclatural combination in the genus from Fiji. PhytoKeys 32: 27–35. doi: 10.3897/phytokeys.32.6663

Abstract

A new species, *Goniothalamus palawanensis* C.C.Tang & R.M.K.Saunders, sp. nov. (Annonaceae), is described from Palawan, Philippines. *Goniothalamus palawanensis* is most closely related to *G. amuyon* (Blanco) Merr., but differs in its shorter inner petals, hairy ovaries, and funnel-shaped stigmas. A new nomenclatural combination, *G. angustifolius* (A.C.Sm.) B.Xue & R.M.K.Saunders, comb. nov., is furthermore validated to reflect the phylogenetic affinities of a Fijian species previously assigned to *Polyalthia*.

Keywords

*Goniothalamus*, *Polyalthia*, Fiji, Malesia, Melanesia, Palawan, new combination, new species

Introduction

The Annonaceae are a species-rich early-divergent angiosperm family, consisting of ca. 108 genera and ca. 2500 species of trees, scandent shrubs and woody climbers (Chatrou et al. 2012), forming an important component of tropical lowland forest ecosystems. The genus *Goniothalamus* (Blume) Hook. f. & Thomson (subfam. Annonoideae Raf., tribe Annoneae Endl.) is one of the largest genera in the family, with more than 130 species (Nakkuntod et al. 2009). The genus is widely distributed in lowland and submontane forests of tropical South-east Asia, with a centre of diversity in western Malesia, particularly Borneo (34 species: Mat-Salleh 2001; Turner and Saunders
2008), Sumatra (14 species: Saunders 2002) and Peninsular Malaysia/Thailand, south of the Isthmus of Kra (22 species: Saunders 2003; Saunders and Chalermglin 2008).

*Goniothalamus* species are small to large trees, with generally solitary, axillary and pendent inflorescences, and are often cauliflorous or ramiflorous. Individual flowers possess one whorl of three sepals, and two whorls of three petals each, with the outer petals larger than the inner. The three inner petals form a distinctive mitriform dome over the reproductive organs, with three lateral apertures at the base of the dome allowing access to beetle pollinators (Saunders 2010, 2012). The flowers are hermaphrodite, with numerous free stamens and carpels. The stamens have broad connectives that cover the thecae; these connectives vary in length and are taxonomically important. The carpels are variable in ovary indument and the size and shape of the stigmatic head. The fruits are apocarpous, with “monocarps” (derived from individual carpels after fertilisation) that are either sessile or borne on stipes.

Fieldwork in Palawan has revealed a previously unknown *Goniothalamus* species, which is formally described here as *G. palawanensis* C.C.Tang & R.M.K.Saunders. The present research also validates a new nomenclatural combination arising from the transfer to *Goniothalamus* of a Fijian species that was formerly classified in *Polyalthia*.

**New species description**

*Goniothalamus palawanensis* C.C.Tang & R.M.K.Saunders, sp. nov.

urn:lsid:ipni.org:names:77134790-1
http://species-id.net/wiki/Goniothalamus_palawanensis

Figs 1, 2

**Diagnosis.** Similar to *Goniothalamus amuyon* (Blanco) Merr. except with shorter inner petals (11–16 mm), hairy ovaries, and filiform pseudostyles with funnel-shaped stigmas.

**Type.** Palawan: Puerto Princesa, Corrigutor, 31 May 2012, C.C. Tang TCC10 (holotype: L; isotypes: PNH).

**Description.** Small trees, to 5 m tall, to 3 cm d.b.h. Young shoots (densely) hairy. Leaf laminae 18–31 cm long, 5.8–11 cm wide, length/width ratio 2.3–3.5, broadly elliptic or oblong elliptic, apex (long) acuminate, base acute, papyraceous to coriaceous, 50–100 µm thick, glabrous both ab- and adaxially; midrib slightly pubescent and very prominent abaxially; secondary veins 8 to 10 pairs per leaf, prominent adaxially; tertiary veins reticulate (sometimes slightly percurrent towards base of leaf), distinct; petioles 8.5–15.5 mm long, 1.5–2.8 mm in diameter, hairy. Flowers axillary, solitary, on young branches, pendent; pedicels 8–13(–16.5) mm long, 0.8–1.2(–1.7) mm in diameter, (sparsely) hairy; bracts 2 to 5. Sepals 3–4(–5) mm long, 3.5–4.5(–6.5) mm wide, length/width ratio 0.6–0.9, generally not reflexed at anthesis, not connate, triangular, 170–250 µm thick, (sparsely) hairy abaxially, glabrous to very sparsely hairy adaxially, green, venation indistinct. Outer petals 20.5–34 mm long, 5.5–13.5 mm wide, length/width ratio 2.4–4.9, broadly to elongated lanceolate, 450–1100 µm
Figure 1. *Goniothalamus palawanensis*, sp. nov. **A** Flowering branch **B** Flower **C** Sepal (ab- and adaxial) **D** Outer petal (ab- and adaxial) **E** Inner petal (ab- and adaxial) **F** Stamen (ab- and adaxial) **G** Carpel. Scale bars: **A** = 5 cm; **B, D, E** = 1 cm; **C** = 5 mm; **F** = 2 mm, **G** = 1 mm; **A** from *C.C. Tang 10* (HKU); **B–G** from *C.C. Tang 14* (HKU); drawing by Caren Pearl Shin.
thick, (densely) hairy both ab- and adaxially, with glabrous region at base of adaxial surface, greenish yellow, venation indistinct. Inner petals 11–16.5 mm long, 5–9.5 mm wide, length/width ratio 1.6–2.5, with 2.3–3.4 mm wide basal claw, 530–800 μm thick, densely hairy abaxially, sparsely hairy adaxially, greenish yellow; apertures between inner petals 3.5–4.5 mm long, 3.5–5 mm wide. Stamens ca. 100 per flower, 1.9–2.2 mm long, 0.3–0.5 mm wide; connectives rounded, 0.2–0.5 mm long, papillate-hairy. Carpels 10 to 15 per flower; ovary 0.8–1.8 mm long, 0.4–0.7 mm wide, densely hairy with long golden-brown hairs; stigmas and pseudostyles 2.4–4 mm long; pseudostyles 0.1–0.3 mm wide, glabrous; stigma funnel-shaped, glabrous. Fruits unknown.

**Phenology.** Flowering specimens collected in May and June; fruiting specimens unknown.

**Distribution and habitat.** Endemic to Palawan (Fig. 3), in mixed dipterocarp and limestone forests; 50–120 m.

**Etymology.** The specific epithet reflects the geographical distribution of the species in Palawan.

**Additional specimens examined (paratypes).** Philippines. **Palawan:** Bloomfield, St. Pauls Bay, Mt. Bloomfield, lowlands to the SSE, 4 May 1984, A. C. Podzorski SMHI2012 (K, L); Iraan Mountains, Aborlan, 29 May 1950, M. D. Sulit 14792 (L); Puerto Princesa, Corrigutor, 31 May 2012, C.C. Tang TCC06 (HKU), C.C. Tang TCC09 (HKU), C.C. Tang TCC11 (HKU), C.C. Tang TCC14 (HKU), C.C. Tang TCC17 (HKU).

**Discussion.** Phylogenetic analysis of chloroplast DNA sequence data (C.C. Tang et al., unpubl.) indicates that this new species, *G. palawanensis*, is sister to *G. amuyon* (Blanco) Merr. with moderate to strong support (posterior clade probability = 0.97 and bootstrap support = 74%), and more distantly related to *G. costulatus* Miq., *G. rufus* Miq., *G. sawtehii* C.E.C. Fischer, *G. tomentosus* R.M.K. Saunders, *G. undulatus* Ridl. and *G. velutinus* Airy-Shaw. These species are all characterised by a distinct indument of rusty-red hairs on the young shoots and petals. Amongst these species, *G. amuyon* and *G. palawanensis* are distinct in possessing fewer secondary veins per leaf (8 to 11, compared with 11 to 25 in the other species, with the exception of *G. rufus*), and in having indistinct sepal venation (although similar venation is observed in *G. velutinus*). *Goniothalamus palawanensis* is furthermore geographically close to *G. amuyon*, which occurs in Luzon, Visayas and Mindanao (Guzman et al. 1986). Morphological differences between *G. palawanensis* and *G. amuyon* include: inner petal length (11–16.5 mm vs 15–29 mm, respectively: Ying 1991; Liao 1996); ovary indument (hairy in *G. palawanensis* [Fig. 1G] vs glabrous in *G. amuyon*); and pseudostyle/stigma shape (filiform pseudostyle with small, funnel-shaped stigma in *G. palawanensis* [Fig. 1G], vs relatively enlarged, fleshy pseudostyle with entire stigma in *G. amuyon*).

The flora of Palawan shows close biogeographical affinities with Borneo, reflecting the extensive connectivity that existed between the two regions (Hall 2009). Two of the species listed above as close relatives of *G. palawanensis* occur in Borneo, viz. *G.
A new species of *Goniothalamus* (Annonaceae) from Palawan...

**Figure 2.** *Goniothalamus palawanensis*, sp. nov. **A** Habit (mature individual with flowers) **B** Branch with leaves (abaxial) **C** Branch with leaves (adaxial) **D, E** Flower **F** Sepals (abaxial) **G** Very mature flower with two outer petals and one inner petal removed, showing stamens and stigmas **H** Perianth parts (abaxial; left to right: sepal, inner petal, outer petal) **I** Perianth parts (adaxial; left to right: sepal, inner petal, outer petal). Scale bars: **H, I** = 1 cm; **A, D** from C. C. Tang 09 (HKU); **B, C, F, G** from C.C. Tang 06 (HKU); **E, H, I** from C.C. Tang 14 (HKU). Photos by C.C. Tang.
rufus and G. velutinus. In addition to the differences in leaf and sepal venation alluded to above, these species differ from G. palawanensis in possessing greatly enlarged and warty pseudostyles/stigmas (Mat-Salleh 1993).

There is only one Goniothalamus species, G. obtusifolius Merr., that is sympatric with G. palawanensis in Palawan. These two species are clearly distinct, however, as G. obtusifolius has much smaller (15–18 × 6–8 cm) coriaceous leaves, and large (ca. 5 × 3.5 cm) membranous outer petals (Merrill 1906).

**IUCN conservation status.** EN B1ab(iii) (IUCN, 2001). Goniothalamus palawanensis is endemic to Palawan, with an extent of occurrence of ca. 1,800 km². The species is only known from three periods of collection (1950, 1984 and 2012), and from fewer than five localities. The region is subject to continuing habitat decline due to logging of low altitude forests (DENR/UNEP 1997), hence the endangered red list category recommendation.

Figure 3. Distribution of Goniothalamus palawanensis, sp. nov., in Palawan.
New nomenclatural combination

Goniothalamus angustifolius (A.C.Sm.) B. Xue & R.M.K. Saunders, comb. nov.
urn:lsid:ipni.org:names:77134791-1
http://species-id.net/wiki/Goniothalamus_angustifolius

Basionym. Polyalthia angustifolia A.C.Sm., Bull. Torrey Bot. Club 70: 538. 1943.
Type: FIJI: Viti Levu, J.W. Gillespie 2198 (holotype: A!; isotypes: BISH, GH!).

Discussion. The historical delimitation of the genus Polyalthia has been shown to be highly polyphyletic, and large-scale taxonomic realignment and recognition of new genera has been undertaken to ensure strict monophyly of genera (Mols et al. 2008; Saunders et al. 2011; Xue et al. 2011, 2012, in press; Chaowasku et al. 2012). As part of this series of taxonomic revisions, chloroplast DNA regions were sequenced from eight species from the Melanesian island of Fiji (Xue, 2013) that had previously been assigned to Polyalthia. Phylogenetic analysis of this data revealed that most of these species align with either Hubera (Chaowasku et al. 2012; Xue 2013) or Meiogyne (Xue 2013; Xue et al. in press), although one species, Polyalthia angustifolia A.C.Sm., which was sequenced from the type material, is nested within the Goniothalamus clade (Xue 2013). Polyalthia angustifolia was originally described from fruiting material (Smith 1943), and it is likely that its incorrect generic affiliation was due to the absence of flowers, which are very different in Polyalthia and Goniothalamus. Subsequent phylogenetic analyses with a larger taxon sampling (C.C. Tang et al., unpubl.) have revealed P. angustifolia as sister to the Fijian species Goniothalamus monospermus (Baill.) R.M.K. Saunders with strong support (posterior clade probability = 1; bootstrap support = 96%); these two species are morphologically distinct, as P. angustifolia seeds lack the broad lateral testa wings that are diagnostic of G. monospermus (Van Setten and Koek-Noorman 1992: pl. 39). The transfer of the name P. angustifolia to Goniothalamus is accordingly validated here.

Acknowledgements

This research was supported by grants from the Hong Kong Research Grants Council (HKU775009 and HKU776713), awarded to RMKS. We are grateful to the directors of the following herbaria for the loan of, or access to, their collections: A, AAU, BKF, BRUN, E, K, L, PNH, SING and US. We are also grateful to Rosario Chit Rubite, Danilo N. Tandang, and Mark Hughes for their support during field work in the Philippines, and Caren Pearl Shin for illustrating the new species.

References

Chaowasku T, Johnson DM, Van der Ham RWJM, Chatrou LW (2012) Characterization of Hubera (Annonaceae), a new genus segregated from Polyalthia and allied to Miliusa. Phytotaxa 69: 33–56.
Chatrou LW, Pirie MD, Erkens RHJ, Couvreur TLP, Neubig KM, Abbott JR, Mols JB, Maas JW, Saunders RMK, Chase MW (2012) A new subfamilial and tribal classification of the pantropical flowering plant family Annonaceae informed by molecular phylogenetics. Botanical Journal of the Linnean Society 169: 5–40. doi: 10.1111/j.1095-8339.2012.01235.x

DENR/UNEP (1997) Philippine Biodiversity: An Assessment and Action Plan. Makati, Philippines: Bookmark.

Guzman E, Umali RM, Sotalbo EM (1986) Guide to Philippine Flora and Fauna. Vol. 3. Quezon City, Philippines: Natural Resources Management Center, Ministry of Natural Resources, and University of the Philippines.

Hall R (2009) Southeast Asia’s changing palaeogeography. Blumea 54: 148–161. doi: 10.3767/000651909X475941

IUCN (2001) IUCN Red List Categories and Criteria, ver. 3.1. Gland, Switzerland and Cambridge, UK: IUCN Species Survival Commission.

Liao J-C (1996) Annonaceae. In: Editorial Committee of the Flora of Taiwan (Ed.) Flora of Taiwan. 2nd ed. Vol. 2. Taipei: Department of Botany, National Taiwan University, 415–419.

Mat-Salleh K (1993) Revision of the genus Goniothalamus (Annonaceae) of Borneo. Unpublished PhD thesis, Michigan State University, East Lansing, Michigan.

Mat-Salleh K (2001) New and noteworthy species of Bornean Goniothalamus (Annonaceae). Folia Malysiana 2: 75–116.

Merrill ED (1906) New or noteworthy Philippine plants, IV. Publications of the Bureau of Science Government Laboratories. Manila 35: 1–68.

Mols JB, Keßler PJA, Rogstad SH, Saunders RMK (2008) Reassignment of six Polyalthia species to the new genus Maasia (Annonaceae): molecular and morphological congruence. Systematic Botany 33: 490–494. doi: 10.1600/036364408785679752

Nakkuntod M, Su YCF, Seelan T, Saunders RMK (2009) Molecular phylogenetic and morphological evidence for the congeneric status of Goniothalamus and Richella (Annonaceae). Taxon 58: 127–132.

Saunders RMK (2002) The genus Goniothalamus (Annonaceae) in Sumatra. Botanical Journal of the Linnean Society 139: 225–254. doi: 10.1046/j.1095-8339.2002.00061.x

Saunders RMK (2003) A synopsis of Goniothalamus species (Annonaceae) in Peninsular Malaysia, with a description of a new species. Botanical Journal of the Linnean Society 142: 321–339. doi: 10.1046/j.1095-8339.2003.00177.x

Saunders RMK (2010) Floral evolution in the Annonaceae: hypotheses of homeotic mutations and functional convergence. Biological Reviews 85: 571–591.

Saunders RMK (2012) The diversity and evolution of pollination systems in Annonaceae. Botanical Journal of the Linnean Society 169: 222–244. doi: 10.1111/j.1095-8339.2011.01208.x

Saunders RMK, Chalermglin P (2008) A synopsis of Goniothalamus species (Annonaceae) in Thailand, with descriptions of three new species. Botanical Journal of the Linnean Society 156: 355–384. doi: 10.1111/j.1095-8339.2007.00762.x

Saunders RMK, Su YCF, Xue B (2011) Phylogenetic affinities of Polyalthia species (Annonaceae) with columellar-sulcate pollen: enlarging the Madagascan endemic genus Fenerivia. Taxon 60: 1407–1416.
Smith AC (1943) Studies on Pacific island plants—III. New and noteworthy flowering plants from Fiji. Bulletin of the Torrey Botanical Club 70: 533–549. doi: 10.2307/2481400

Turner IM, Saunders RMK (2008) Four new species of Goniothalamus (Annonaceae) from Borneo. Nordic Journal of Botany 26: 329–337. doi: 10.1111/j.1756-1051.2008.00359.x

Van Setten AK, Koek-Noorman J (1992) Fruits and seeds of Annonaceae: morphology and its significance for classification and identification. Bibliotheca Botanica 142: 1–101, pl. 1–50.

Ying S-S (1991) Coloured Illustrated Flora of Taiwan. 2nd ed. Vol. 1. Published by the author. [In Chinese]

Xue B (2013) Molecular phylogenetics of Polyalthia (Annonaceae): identifying clades and morphological synapomorphies in a large polyphyletic genus. Unpublished PhD thesis, The University of Hong Kong.

Xue B, Su YCF, Mols JB, Keßler PJA, Saunders RMK (2011) Further fragmentation of the polyphyletic genus Polyalthia (Annonaceae): molecular phylogenetic support for a broader delimitation of Marsypopetalum. Systematics and Biodiversity 9: 17–26. doi: 10.1080/14772000.2010.542497

Xue B, Su YCF, Thomas, DC, Saunders RMK (2012) Pruning the polyphyletic genus Polyalthia (Annonaceae) and resurrecting the genus Monoon. Taxon 61: 1021–1039.

Xue B, Thomas DC, Chaowasku T, Johnson DM, Saunders RMK (in press) Molecular phylogenetic support for the taxonomic merger of Fitzalanla and Meiogyne (Annonaceae): new nomenclatural combinations under the conserved name Meiogyne. Systematic Botany.
