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Nomenclatural changes and new species in Malesian *Homalomena* (Araceae)

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Abstract. The genus *Furtadoa* M. Hotta (Araceae) is reviewed, with its morphological characteristics compared to those of *Homalomena* Schott, and its molecular phylogenetic position analyzed in relation to other *Homalomena* species. A comparative assessment of molecular data supports the reclassification of *Furtadoa* within *Homalomena*, resulting in the establishment of two new combinations. Two species names are changed: *H. indrae* for *F. indrae* and *H. sumatrensis* for *F. sumatrensis*. In this paper, we also describe a new species of '*Furtadoa*-like' *Homalomena* from Riau, Sumatra, *H. chikmawatiae* A.S.D.Irsyam & M.R.Hariri. This new species is readily identified by its peltate leaves and large sterile appendix at the spadix.

Keywords: Aroid, *Homalomena*, internal transcribed spacer, Malesia, Sumatra.

INTRODUCTION

The genus *Furtadoa* M.Hotta was published in 1981 by Mitsuru Hotta (1935–2015). The genus was previously distinguished by its basal placentation, the presence of a pistillode in each staminate flower, and the male florets each consisting of a single, transversely orientated stamen (Hotta 1981; Mayo et al. 1997). In contrast, the genus *Homalomena* is characterized by parietal and axile placentation, the absence of pistillodes, and possesses 2–4 stamens in each staminate flower (Mayo et al. 1997; Boyce and Wong 2015). It comprised three species in Western Malesia: *F. indrae* P.C.Boyce & S.Y.Wong, *F. mixta* (Ridl.) M.Hotta, and *F. sumatrensis* M.Hotta (Hotta 1981; Hotta 1985; Boyce and Wong 2005). *Furtadoa mixta* is indigenous to Peninsular Malaysia, while the other two species are endemic to Sumatra.

Recent molecular analysis carried out by Haigh et al. (2023) and Vasconcelos et al. (2023) indicates that the genus *Furtadoa* is polyphyletic, implying that its species do not share a single common ancestor and are instead distributed across multiple evolutionary lineages within *Homalomena*. This finding necessitates a critical reassessment of the taxonomic placement of

Furtadoa. In this study, we address this taxonomic inconsistency by proposing the reclassification of *Furtadoa* as a synonym of *Homalomena*. This decision is also supported by our molecular phylogenetic evidence comparisons, which demonstrate closer evolutionary relationships between *Furtadoa* species and certain clades within *Homalomena*. By integrating these findings, this reclassification provides a more accurate representation of the evolutionary relationships within the *Homalomena* and underscores the importance of revisiting traditional classifications in light of molecular data.

Moreover, in July 2024, we observed an unusual aroid obtained from Sumatra. It is clearly classified as a '*Furtadoa*-like' *Homalomena* due to its resemblance in having unistaminate male florets, pistillodes, and basal placentation. The plant possesses a larger size than the three previously identified *Homalomena* with '*Furtadoa*-type' spadices. After a meticulous morphological examination, we considered this distinct specimen as a new species. This publication establishes *H. chikmawatiae* A.S.D.Irsyam & M.R.Hariri as the fourth species of *Homalomena* with '*Furtadoa*-type' spadix in Malesia.

MATERIALS & METHODS

The morphological description was based on living specimens from a private nursery in Bogor, West Java. The plant was initially collected in March 2022 by local people in Riau Province, Sumatra. The morphological features were examined and photographed using the Dinolite digital microscope at the National Research and Innovation Agency (BRIN), Cibinong. Morphological data were compared to the taxonomic literature on Malesian *Furtadoa* (Hotta 1981; Hotta 1985; Boyce and Wong 2005). The preliminary conservation status was assessed using the IUCN Standards and Petitions Committee's (2024) guidelines.

The DNA was extracted from the leaf of the new species using the TianGen Plant Genomic DNA Kit, manufactured by TIANGEN Biotech, Beijing. The internal transcribed spacer sequence following Sun et al. (1994) was amplified using the universal primers for ITS. A 50 µl reaction mixture was utilized for the PCR reaction. This mixture contained 10 ng of DNA template, 5 µM each of forward and reverse primers, 25 µl of MyTaq HS Red Mix (Bioline, USA), and 11 µl of distilled water. The amplification procedure involved an initial pre-denaturation step at 94°C for 5 minutes, followed by 35 cycles of denaturation at 94°C for 15 seconds, annealing at 58°C for 15 seconds, and extension at 72°C for 15 seconds. A final post-extension step was performed at 72°C for 5 minutes to complete the process. The PCR products were then visualized utilizing a Bio-Rad GelDoc imaging system after electrophoresis on a 1% florosafe stained-agarose gel. The PCR product was sequenced at 1st Base in Malaysia, utilizing the PT Genetika Science service.

Sequencing data were meticulously processed using MEGA 11 (Tamura et al. 2021). Sequence data for *Homalomena* and *Furtadoa* were retrieved from the NCBI database, complemented by additional *Homalomena* species identified through BLAST searches to ensure a good representation of the genus. To root the phylogenetic tree, *Philodendron* and *Adelonema* were included as an outgroup, given its taxonomic proximity to *Homalomena* within the Araceae family. The phylogenetic tree was constructed using the Maximum Likelihood method implemented in IQ-TREE, with the TIM2+F+R2 substitution model selected based on the best-fit Bayesian Information Criterion (BIC). Visualization of the resulting tree was performed using the Interactive Tree of Life v7 (iTOL) web platform (Trifinopoulos et al. 2016; Letunic and Bork 2024).

TAXONOMIC TREATMENT

Homalomena Schott, in H.W.Schott & S.L.Endlicher, Melet. Bot.: 20 (1832).

Type species: *Homalomena cordata* Schott, lectotype designated by Nicolson (1967: 517).

Furtadoa M.Hotta, Acta Phytotax. Geobot. 32: 142 (1981), **syn. nov.**

Type species: *Furtadoa sumatrensis* M.Hotta

New combinations

Homalomena indrae (P.C.Boyce & S.Y.Wong) M.R.Hariri & A.S.D.Irsyam, **comb. nov.**

Bas.: *Furtadoa indrae* P.C.Boyce & S.Y.Wong, Aroideana 39(1): 15 (2016).
Type: Indonesia, Sumatra: Riau, Kuantan Singingi Regency, Kuantan Tengah Subdistrict, Taluk Kuantan, c. 0°31'55.06"S 101°34'58.44"E, c. 50 m asl, 16 Apr 2015, *Indra AR-5196* (holotype ANDA; isotype BO, BOKR, SAR).

Homalomena sumatrensis (M.Hotta) M.R.Hariri & A.S.D.Irsyam, **comb. nov.**

Bas.: *Furtadoa sumatrensis* M.Hotta, Acta Phytotax. Geobot. 32(5&6): 142 (1981).

Type: Indonesia, Sumatra: West Sumatra, Ulu Gadut, about 15 km east from Padang city, alt. 350 m, on wet rocks along the stream, Feb. 22 1981, *M. Hotta 25000* (holotype KYO).

New species

Homalomena chikmawatiae A.S.D.Irsyam & M.R.Hariri, **sp. nov.** (Fig. 1)

Type**:** Indonesia, Java, cultivated in a private nursery from material collected in the wild ex Indonesia: Sumatra, Riau Province (*orig. coll.* March 2022, *anonymous s.n.*), voucher 27 July 2024, *MR Hariri & ASD Irsyam s.n.* (holotype FIPIA; isotype BO).

Diagnosis

Homalomena chikmawatiae is readily distinguishable from other *Homalomena* species with '*Furtadoa*-type' spadices by its clearly peltate leaves and the conspicuous sterile appendix at the upper $^{2}/_{5}$ of the spadix.

Description

Medium mesophytic herb up to 34 cm height. Stem ca. 1.5 mm diam.; internodes obscured by overlapping leaf bases. Leaves ca. 8 per crown; wing of sheath fully adnate to petiole, 1.5–2.7 mm long, red; petiole terete, 15.5–22.0 cm long, 3–4 mm diam., curved, aromatic, reddish to green; leaf blade ovate, peltate, 10.2–13.2 × 5.8–9.3 cm, base weakly cordate, margin entire, apex acute to mucronate, adaxial leaf surface olive green to dark green, abaxial leaf surface pale green; midrib yellowish green adaxially, raised abaxially; primary lateral veins 7–8 on each side. Inflorescences paired, subtended by a short red prophyll; peduncle short, ca. 4 mm long, terete, exceeding the leaves, reddish. Spathe ca. 3 cm long, ca. 7 mm diam., unconstricted, pale amber to pale rose, greenish at the apex, creamy inside. Spadix cylindrical, obtuse at the apex, ca. 19 mm long, including stipe; stipe ca. 1.3 mm long, creamy white; pistillate flower zone cylindric, ca. 6.7 mm long, shorter than the male zone; *pistils* globose to bottle-shaped, 0.9–1 mm height, 0.6–0.8 mm diam., creamy white, stylar region white; stigma button-like, 0.4–0.5 mm diam., white; staminode 1 per pistillate flower, globose, 0.4–0.5 mm diam., creamy white; staminate flower zone ca. 11 mm long (including appendix), cylindrical, with a sterile appendix at the upper two fifths of the spadix, obtuse at apex; staminate flowers consisting of a solitary transverse stamen and a pistillode; stamens 0.8–1.2 mm diam., pores on the ventral side of the flower with respect to the spadix axis, creamy white; pistillodes comprised of an atrophied ovary and a well-developed style topped with a vestigial stigma, 0.70–0.85 mm long, creamy white. Fruiting spathe, fruits, and seeds not observed.

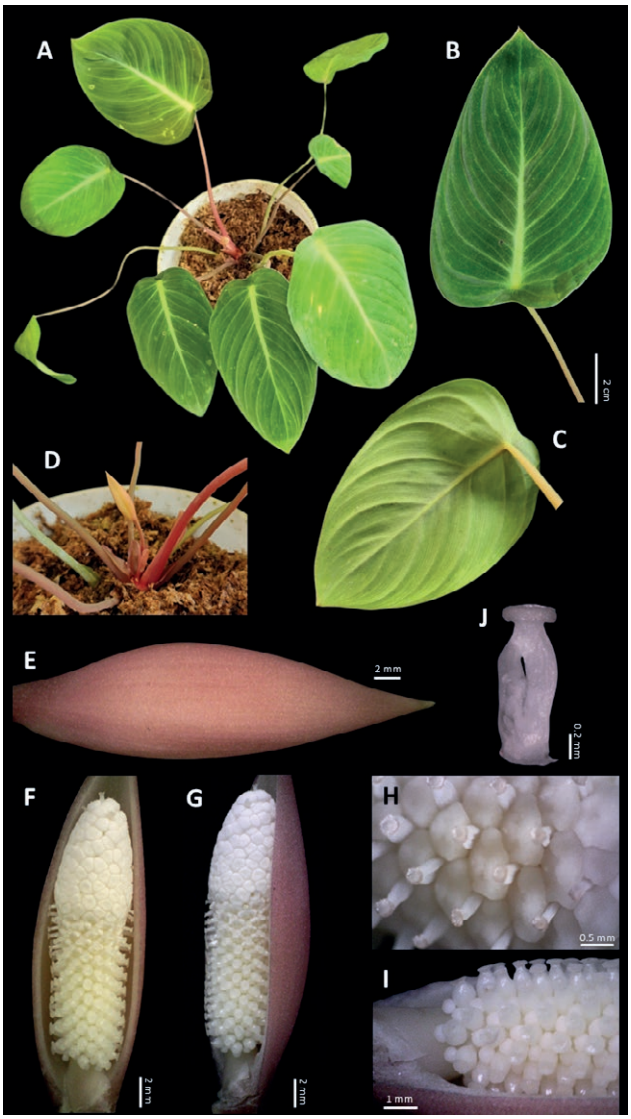

Figure 1. *Homalomena chikmawatiae*. A. Habit; B. Adaxial leaf surface; C. Abaxial leaf surface; D. Inflorescence; E. Spadix; F, G. Spadix with half of spathe removed artificially showing huge sterile spadix appendix; H. Part of upper spadix showing staminate flowers and pistillodes; I. Part of lower-half spadix showing pistillate flowers and staminodes; J. Pistil with basal placentation.

Etymology

The species epithet *chikmawatiae* is dedicated to Prof. Dr. Ir. Tatik Chikmawati, M.Si., an Indonesian academic from Biology Department - IPB University renowned for her contributions to the study on plant biosystematics of Indonesian flora.

Distribution and ecology

The new species is only known from Riau, Sumatra.

Proposed conservation assessment

Currently, only one population of the new species with an unclear number of individuals observed. *Homalomena chikmawatiae* distribution is only known from its single locality, but we speculate that there may be other populations of this new species. Due to not enough field investigations, the natural range of this species in the wild is unclear. As a result, we recommend this species placement in the 'Data Deficient' (DD).

Note

Slightly peltate leaves are also present in robust individuals of *H. mixta* Ridl. However, that species is distinguished by the absence of a sterile spadix appendix (see Boyce & Wong 2015). Another Sumatran species, *H. monandra* M.Hotta, also exhibits monandrous male florets with single transverse stamens, similar to *H. chikmawatiae*. Nevertheless, *H. monandra* lacks pistillodes.

Building upon the findings of Haigh et al. (2023) and Vasconcelos et al. (2023), it is evident that *Homalomena* should be reclassified within the Philodendreae (*Philodendron* clade) rather than being retained within the Homalomeneae, which ought to be treated as a synonym of Philodendreae. This reclassification is underpinned by robust molecular and morphological evidence, emphasizing the necessity for a comprehensive revision of the genus's taxonomic placement to reflect its evolutionary relationships more accurately.

The phylogenetic analysis provides significant insights into the genetic diversity and evolutionary relationships within *Homalomena*, offering a more nuanced understanding of its taxonomy and interspecific dynamics. Notably, the analysis indicates that *F. mixta* (now returned to *Homalomena* as *H. mixta* Ridl.) and *F. sumatrensis* (here transferred to *Homalomena* as *H. sumatrensis*) are not monophyletic but are instead nested within *Homalomena* in distinct clades (Fig. 2), consistent with the findings of Wong et al. (2016), Haigh et al. (2023), and Vasconcelos et al. (2023). Given that the necessary taxonomic revisions have yet to be implemented, it is proposed that species currently classified under *Furtadoa* be formally transferred to *Homalomena*.

Homalomena mixta is resolved within the Chamaecladon Supergroup (SG), while *H. sumatrensis* is posi-

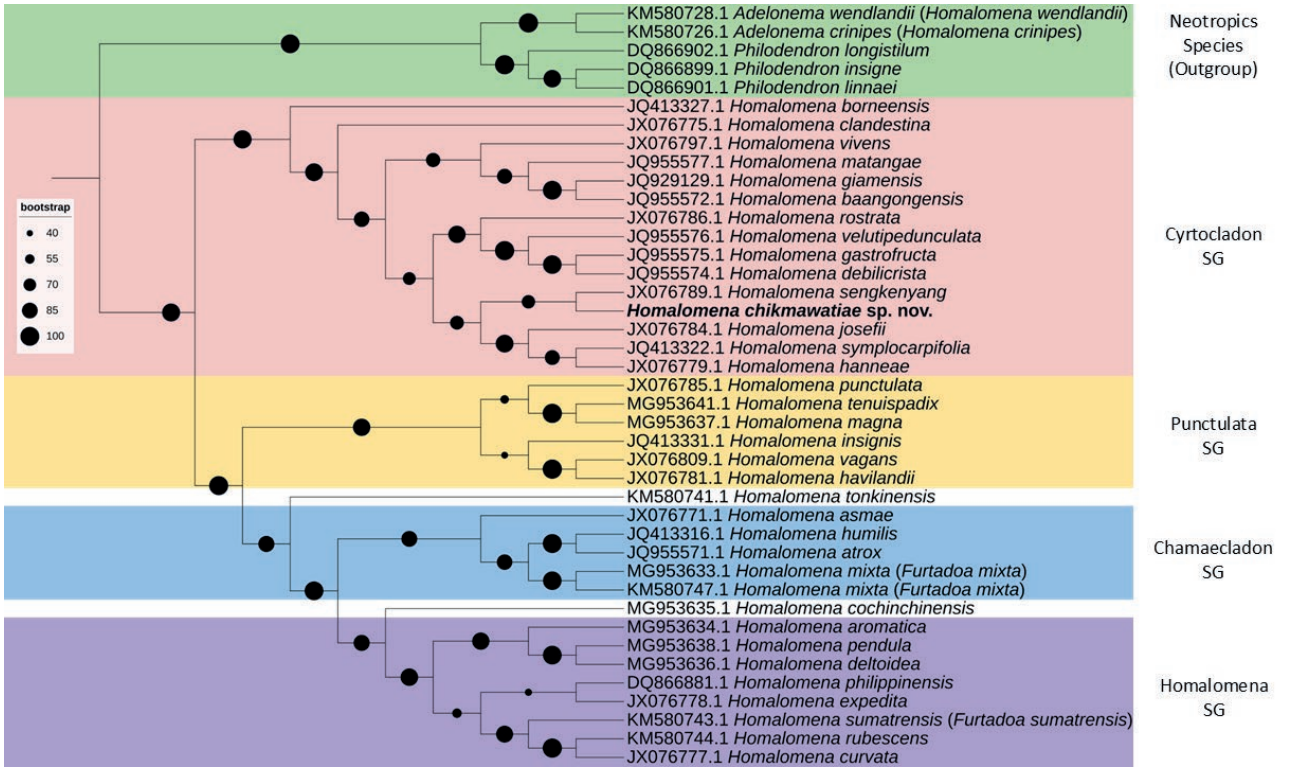

Figure 2. Phylogenetic tree of *Homalomena* based on ITS sequence showing the disparate positions of *Homalomena chikmawatiae* and two other species previously under the genus *Furtadoa*.

tioned within the Homalomena SG. Interestingly, our newly identified species occupies a separate clade, distinct from other species exhibiting the '*Furtadoa*'-type spadix morphology, and is placed within the Cyrtocladon SG. Further investigation, including molecular data for *F. indrae* (here transferred to *H. indrae*), is essential to clarify its phylogenetic position and to better understand its placement within the broader *Homalomena* genus.

The Cyrtocladon SG represents a distinct and well-supported clade within *Homalomena*, characterized by its prominent morphological features. These include large inflorescences with a spathe that is distinctly divided into two regions: a basal portion and an upper limb. Inflorescences during anthesis with complex spathe and spadix movements and oftenspadix elongation (Kiaw et al. 2011). These defining traits, however, are absent in *H. chikmawatiae*. Unlike other members of Cyrtocladon SG, *H. chikmawatiae* possesses a unique combination of features, including a pistillate flower zone containing interpistillar staminodes — a characteristic commonly observed in Cyrtocladon SG. Despite this similarity, *H. chikmawatiae* is distinctively having uncommon peltate leaves, large sterile appendix at the spadix, and unilocular ovary, with basal placentation, setting it apart from the typical species of this supergroup.

The novel species is positioned within the Cyrtocladon SG in the phylogenetic tree constructed based on ITS sequence data. However, morphologically, the characteristics exhibited by *H. chikmawatiae* differ significantly from the typical traits observed within the supergroup, especially the presence of sterile appendix which is unusual to this genus. This suggests that the morphological diversity within Cyrtocladon SG is broader than previously understood, with certain traits potentially representing outliers. Wong et al. (2013) previously reported similar findings, noting the absence of staminodes in *H. vivens* P.C.Boyce, S.Y.Wong & Fasih., a characteristic typically associated with Homalomena SG and Punctulata SG, rather than Cyrtocladon SG.

Additionally, the number of stamens per staminate flower exhibits considerable variation across species. While the general range for Cyrtocladon SG is 2–4 stamens, *H. chikmawatiae* is characterized by having only a single stamen per flower (Wong et al. 2013). This trait is reminiscent of *H. mixta* and *H. sumatrensis*, species that are distributed across two different supergroups, namely Homalomena SG and Chamaecladon SG based on the phylogenetic tree. The presence of such unique morphological features in *H. chikmawatiae* underscores the complexity and variability within the genus *Homalomena*. These findings highlight the challenges in establishing robust morphological groupings within this genus, which is recognized as one of the largest and most taxonomically complex groups within the family Araceae.

To address these complexities, further comprehensive studies are required to unravel the relationships among species within *Homalomena*. These investigations should integrate both molecular and morphological approaches to provide a more holistic understanding of species delimitation and phylogenetic relationships. Ultimately, such studies may necessitate a reorganization of the genus, potentially leading to the establishment of new SG that better reflect the evolutionary and morphological diversity of *Homalomena*.

Based on the findings of this study, an updated taxonomic key for the *Homalomena* species resembling the '*Furtadoa*-like' group in Western Malesia has been developed and is presented below. This updated key serves as a comprehensive and systematic tool for identifying species within this morphologically complex group. The revision incorporates both newly described species and re-evaluated diagnostic traits in previous identification frameworks.

Updated key to the species of *Homalomena* with '*Furtadoa*' spadix morphology (modified from Boyce & Wong, 2015)

1. A. Mesophytic herb, peduncle short (c. 6–9 × as long as spathe), pistils white 2

   B. Rheophytic herb, peduncle long (at most 3 × as long as spathe), pistils greenish 3

2. A. Inflorescences in fascicles of up to 7, spadix sessile, pistillodes conical, sterile appendix absent ..... ***Homalomena mixta***

   B. Inflorescence in pair, spadix stipitate, pistillodes bottle-shaped, sterile appendix present ..... ***Homalomena chikmawatiae***

3. A. All staminate flowers associated with a pistillode; pistils bottle-shaped, rich green; stigma ¼ diam. of pistil; leaf blades thinly membranous on short (¼ leaf blade length) petioles ..... ***Homalomena indrae***

   B. Terminal portion of spadix comprised of staminate flowers lacking pistillodes; pistils globose, pale cream; stigma ½ diam. of pistil; leaf blades coriaceous on a long (¾ to exceeding leaf blade length) petioles ..... ***Homalomena sumatrensis***

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