

An addition to the alien flora of Java: the first record of adventive *Costus dubius* (Costaceae)

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Abstract: More than 6000 plant species, native and introduced, have been recorded in Java that includes the Costaceae family. In the last few years, several additions of alien *Costus* species have been published from Java. In 2019, a set of specimens of wild *Costus* sp. was collected from Institut Pertanian Bogor, Bogor, West Java Indonesia. This species is not similar to any previously recorded wild *Costus* in Java. Therefore, this research aims to identify the collected specimen and provide a taxonomic account for the species. The morphological description was made from the living plant and the collected herbarium. The description was used to identify the species, supported by field notes and photographs. The result showed that the recently collected specimen belongs to *Costus dubius*. Before this finding, the plant was only known in cultivation in the Bogor Botanical Garden. Therefore, this finding represents the first record of the adventive population of *C. dubius* in Java and increases the number of wild *Costus* in Java into seven species. Further researches on *Costus* in Java are suggested such as the ecological impact due to the presence of several non-native species.

Keywords: alien plant; herbs; Java; taxonomy

Introduction

The publication of the Flora of Java by Backer and Bakhuizen van den Brink (1963; 1965; 1968) is one of the most monumental works to the flora of Java. More than 6000 species native and introduced have been reported. With the gap of more than a half century ago, many new discoveries either new taxon (Mahyuni *et al.*, 2018) or new records of native (Puspitaningrum *et al.*, 2017) or alien plants (Irsyam & Mountara, 2018; Irsyam *et al.*, 2019a, 2019b, 2020) have been published.

Costaceae is one of the plant families that can be found in Java. The latest taxonomic account on the Costaceae of Java has been published by Backer & Bakhuizen van den Brink (1968). Later, no more published accounts are available until the 2000s and only Maas (1979) who provided an updated account for all Malesian species where Javan species are also discussed.

Costus is a genus with perhaps as many as 81 to 95 species (Specht, 2006; Specht and Stevenson 2006) and according to POWO

(2021), there are 100 accepted species. This genus can be found from the tropics to subtropic regions of the world (POWO, 2021; Wu & Larsen, 2000). In 2013, a nomenclatural changes was made in the genus *Costus*, where some species was transferred to *Hellenia* (Govaerts, 2013), but this concept seems not acceptable except in some database like Co's Digital Flora of the Philippines (Pelser *et al.*, 2011-onwards). Many species of *Costus* have been cultivated as ornamental in Java (Nisyawati and Mustaqim, 2017; Skinner, 2016) and some of them possess medicinal properties like in *Costus afer* Ker-Gawl (Boison *et al.*, 2019).

After the 2000s, further records of *Costus* species in Java were provided by Sari *et al.* (2010), Nisyawati & Mustaqim (2017), Sari *et al.* (2010), and Irsyam *et al.* (2019). Sari *et al.* (2010) mentioned that *C. dubius* has been cultivated in Bogor Botanic Gardens based on the seed they brought in from The Netherlands. Nisyawati & Mustaqim (2017) reported the occurrence of *Costus lucanusianus* J. Braun & K. Schum., *Costus malortieanus* H. Wendl., and *Costus scaber* Ruiz & Pav. in their local flora account of

Universitas Indonesia, Depok, West Java. The latest record was made by Irsyam *et al.* (2019b) on *Costus afer* Ker Gawl. In this paper, we present a record for *Costus dubius* (Afz.) K. Schum. in Java based on an adventive population for the first time.

Material and Methods

Field collecting was conducted in the year of 2019 in IPB University campus area supported by previous botanical explorations by both authors since 2017 (Figure 1). According to our field explorations, only one wild population of the targeted species that has been found in IPB University area. Specimen was collected following the standar guideline from Bridson and Forman (1992).



Figure 1. A. Map showing the location of *Costus dubius* population in IPB University, Bogor, West Java. B. Vegetation where *C. dubius* was found in IPB University. Photos B by E. Setiawan.

Morphological data of the species were prepared based on dried herbarium materials for the vegetative parts and fresh materials for the generative part including the inflorescence. The

identification of the materials was done by using a comparison to descriptions and photographs to many published literatures including Backer & Bakhuizen van den Brink (1968), Maas (1979), Kramer *et al.* (2017), Mustaqim & Nisyawati (2017) and Irsyam *et al.* (2019).

Results and Discussion

A. Taxonomic Treatment and Morphological Description

Costus dubius (Afzel.) K. Schum.: 409 (1904); Maas-van der Kamer *et al.* Blumea 61: 295 (2016). - Basionym: *Zingiber dubium* Afzel, Rem. Guin. II: 9 (1813).

Terrestrial herb up to 3 m tall. Leaves many; ligule chartaceous, nearly truncate to usually 2-lobed, 1–16 mm long; petiole 3–10 mm long; sheaths, ligule, and petiole clad with subspreading laxly puberulous hairs, distinct in young plants, mostly up to c. 0.25 mm and very rarely longer, scabrid with age; lamina shiny above, thinly coriaceous, narrowly elliptic or less frequent obovate, (8–)16–32 × (3.6–)5–10 cm, upper side minutely puberulous similar to sheaths, lower side glabrous, except the two length side of the midrib, margin often with a row of hairs < 1 mm long especially in the upper portion, base cuneate, truncate at the very base, apex acuminate, acumen short in smaller individual, and up to 3 cm long in the larger leaves. Inflorescence many-flowered, vary from globose to ovoid or ellipsoid or subcylindric and tapering to apex, 5.5–13 × 4.75–7 cm, borne from the separate leafless shoot up to 40 cm long, one flower bloom at a time. Bracts hairy on the upper dorsal, otherwise glabrous, bracteoles, calyx hairy at the base near the transition with the ovary, corolla glabrous, stamens and style glabrous, ovary with hairs at some parts of the apex. Flowers 1 per bract; bracts green with light margins, margins becoming brownish in the later stage coriaceous, bulging, sterile bracts broadly subobovate, convex, ca. 3.5 × 4.35 cm, sometimes bearing leaf-like organs at the apex, fertile bracts becoming narrower to the apex of the inflorescence, lowest one very broadly subobovate, up to 3.55 × 3.8 cm, smaller upward, appendages absent; bracteole falcately boat-shaped, ca. 21.5 mm long, apex bilobed; calyx subinfundibuliform, ca. 17 mm long including the 3 mm long, broadly ovate-triangular lobes,

callus very inconspicuous; corolla white 45 mm long, glabrous, tube 13 mm long, dorsal lobes elliptic, 3.5×1.45 mm, lateral lobes smaller and narrower than the dorsal ones, lobes narrowly subobovate-elliptic, 3×0.95 cm long; labellum white, inner side with central yellow nectar guide, funnel-shaped, subcampanulate, broadly obovate when spread out, ca. 3.7×3.6 cm, margin crenate in the 1/3 apex; stamen white, very slightly creamy, elliptic, 2.8×1.2 cm, anther 7.5×4.5 mm long. Ovary white, ovoid, 6×5 mm, style filiform, 3.45 mm long, stigma yellowish, 2.5×2.5 mm. Capsule ellipsoid, 12.5×1 cm. Seeds black, 2.5×2 mm including the fleshy white-transparent aril (Figure 2 and 3).

Specimens examined: INDONESIA. West Java, Bogor, Dramaga, Institut Pertanian Bogor, near SEA FAST, under cultivated durian tree, 3 Feb 2019, Mustaqim & Setiawan 2303 (FIPIA!).

B. Distribution and Ecology

This species is native to tropical Africa (Maas-van der Kamer *et al.*, 2016). The previous record in Malesia was made by Maas (1979) from a cultivated plant in Singapore Botanic Gardens and Sari *et al.* (2010) from plants cultivated in Bogor Botanic Gardens. The adventive population in Java so far known only from the Western part of the island, but maybe also already become adventive elsewhere. The population was found on an abandoned land within a campus area. The plants have already become locally abundant in more or less shaded and humid situations. Flowering seems throughout the year.

C. Important Characters, Notes, and Key Identification for Javan *Costus* Species

In Java, this species can be recognized solely by the inflorescence that is borne on a separate leafless stem. The plants are strongly assumed to have become naturalized or maybe to a lesser extent, relict of cultivation. Compared to the description in Maas-van der Kamer *et al.* (2016), we did not find terminal inflorescences and two flowers per bracts in Javan materials. Besides that, we also found that the plants are clad with the minute and subspreading hairs that detached with age and becoming subglabrous. The upper dorsal sides of the bracts are also clad with some hairs. Such difference may be caused

by the facts that Maas-van der Kamer *et al.* (2016) mostly describe the species based on dried materials, which we observed that indumentum is hardly recognized and only appears as powder-like materials. To facilitate the identification of Javan species of *Costus*, a key is presented below (partly adopted from Maas (1979) and Proctor (2005)):

- 1a. Leaves villose above *C. malortieanus*
 - 1b. Leaves glabrous or sparsely hairy but not villous beneath 2
 - 2a. Spikes borne on separate leafless shoots
..... *C. dubius*
 - 2b. Spikes terminal on leafy shoots 3
 - 3a. Spikes bracts red or orange red *C. scaber*
 - 3b. Spikes bract green or sometimes flushed with reddish 4
 - 4a. Bracteoles always or mostly two, rarely 1, per bract 5
 - 4b. Bracteoles one per bract 6
 - 5a. Ring of hairs on the nodes complete; bracts green *C. lucanusianus*
 - 5b. Ring of hairs on the nodes incomplete; bracts reddish *C. afer*
 - 6a. Bracts herbaceous, bracteoles tubular
..... *C. cuspidatus*
 - 6b. Bracts coriaceous to chartaceous, bracteoles boat-shaped *C. laevis*
- ## Conclusion
- With the addition of *C. dubius* as an adventive or possibly also capable of become naturalized or even invasive in Java, the number of species for *Costus* in Java is now increased to seven. Further research in the taxonomy of genus *Costus* or Costaceae family, distribution and studies on some other aspects, such as the ecological impact of the adventive or naturalized species, are encouraged.



Figure 2. *Costus dubius* (Afzel.) K.Schum.: A, leafy shoot; B, close up of stem (scale = 1 cm); C, inflorescence (scale = 5 cm); D, flower (scale = 2 cm). All from Mustaqim & Setiawan 2303. Photos by W.A. Mustaqim.



Figure 3. *Costus dubius* (Afzel.) K.Schum.: A, inflorescence from a separate leafless shoot (scale = 5 cm); B, flower (scale = 1 cm); C, bract (scale = 1 cm); D, bracteole (scale = 1 cm); E, calyx (scale = 1 cm); F, dorsal petal (scale = 1 cm); G, lateral petals (scale = 1 cm); H, floral part with perianth and labellum removed (scale = 1 cm); I, labellum (scale = 1 cm); J, capsule crowned by persistent calyx. All from Mustaqim & Setiawan 2303. Photos by W.A. Mustaqim.

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