

Short Communications

Plukenetia volubilis L.: A New Record of a Cultivated Alien Species in Java

Alexander Tianara^{1,2}, Windri Handayani², Arifin Surya Dwipa Irsyam^{3*}, Muhammad Rifqi Hariri⁴, Asih Perwita Dewi⁴, Peniwidiyanti Peniwidiyanti^{5,6}, Muhammad Hisyam Baidlowi⁶, Dian Rosleine⁷, Mega Atria^{1,2}

1)Herbarium Depokensis (UIDEP), Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Indonesia, Pondok Cina, Beji, Depok City, West Java, 16424, Indonesia

2)Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Indonesia, Pondok Cina, Beji, Depok City, West Java, 16424, Indonesia

3)Herbarium Bandungense (FIPIA), School of Life Sciences and Technology (SITH), Institut Teknologi Bandung (ITB), Labtek VC Building, Jl. Let. Jen. Purn. Dr (HC) Mashudi No. 1 Jatinangor, West Java, 45363, Indonesia

4)Research Center for Biosystematics and Evolution, National Research and Innovation Agency (BRIN), Jl. Raya Jakarta-Bogor Km. 46, Cibinong, West Java, 16911, Indonesia

5)Research Center for Ecology and Ethnobiology, National Research and Innovation Agency (BRIN), Jl. Raya Jakarta-Bogor Km. 46, Cibinong, West Java, 16911, Indonesia

6)Botani Tropika Indonesia Foundation (BOTANIKA), Jl. Seruni No. 25, Loji, Bogor, West Java, 16117, Indonesia

7)Ecology Research Group, School of Life Sciences and Technology (SITH), Institut Teknologi Bandung (ITB), Labtek XI Building, Jl. Ganesha No. 10 Bandung, West Java, 40132, Indonesia

* Corresponding author, email: arifin@itb.ac.id

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ABSTRACT

Plukenetia volubilis L. has been documented as a new record for the first time in Java, Indonesia. The species is easily distinguished from the native species, *P. corniculata* Sm., by its exstipellate basilaminar-glands, long cylindrical column, and wingless fruit-lobes. *Plukenetia volubilis* is cultivated mainly in South America for its beneficial values as food and medicine and was recently introduced to Asia. However, its occurrence in Java has not been reported. We collected specimens from West Java (Depok City, Bandung Barat and Sumedang Regency) and East Java (Malang Regency). Morphological description, identification key, and photographs of the species are provided.

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The plant diversity in Java has been extensively studied, primarily since the Flora of Java was published in three volumes in 1963, 1965, and 1968. However, previous studies proved that the number of taxonomic studies has recently increased in Java. There have been numerous reports on the newly discovered native species in published works (Djarwaningsih 2010; Djarwaningsih 2012; Djarwaningsih 2013; Puspitaningrum et al. 2017; Metusala & Supriatna 2017; Rahayu & Rodda 2019). Furthermore, various authors have also recorded many additional alien species from the island (Hariri et al. 2019; Effendi & Mustaqim 2021; Mustaqim & Setiawan 2021; Irsyam et al. 2021; Peniwidiyanti et al. 2021; Al Anshori et al. 2022; Irsyam et al. 2022). It demonstrates that taxonomic studies on plant diversity in Java are still important.

Some additional alien species of the Euphorbiaceae *sensu lato* have been discovered on Java over the past five years, both naturalized and

cultivated, namely *Caperonia palustris* (L.) A.St.-Hil. (Al Anshori et al. 2020), *Cathetus myrtifolius* (Wight) R.W.Bouman (Hariri et al. 2020), *Cnidoscolus aconitifolius* (Mill.) I.M.Johnst. (Irsyam et al. 2020), *Croton bonplandianus* Baill. (Al Anshori et al. 2020), *Euphorbia graminea* Jacq. (Irsyam et al. 2019), *E. hyssopifolia* L. (Irsyam et al. 2019), and *Moeroris tenella* (Roxb.) R.W.Bouman (Hariri et al. 2020). Other undiscovered additional species may still occur on the island. Thus, this study aims to update the information on the Alien Flora of Java, particularly the Euphorbiaceae. The data will be used to prepare the database of alien plant species on the island.

Plukenetia L. is a tropical genus with 21 species distributed in tropical areas from Mexico, Africa, South Asia, to Southeast Asia and throughout Malesia (Cardinal-McTeague & Gillespie 2016; Cardinal-McTeague & Gillespie 2020). The genus is a monoecious or rarely dioecious vine. Its distinctive characteristics include papery leaves, a leaf base with two raised glands on the adaxial surface, 8–13 free stamens, and winged or horned capsules (van Welzen 2020). *Plukenetia corniculata* Sm., previously classified under *Pterococcus* Hassk., is the only species that naturally occurs in Asia, such as Thailand (Gillespie & Larsen 2023) and Singapore (Choo et al. 2022), including Java (Backer & Bakhuizen van den Brink 1963). In this study, we formally report the occurrence of *P. volubilis* L. for Java, a new cultivated alien species for Java. It is an introduced species from South America. Our discovery becomes the second species of *Plukenetia* found in Java. Botanical exploration was conducted in West Java (Depok City, Bandung Regency, and Sumedang Regency) and East Java (Malang Regency) from January to May 2023. Field exploration was carried out using a method based on Rugayah et al. (2004). Plant material collection and processing follows Bridson & Forman (1998). Plant materials were documented and observed at Herbarium Depokensis (UIDEP), Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Indonesia and Herbarium Bandungense (FIPIA), School of Life Sciences and Technology, Institut Teknologi Bandung. Specimen checking was conducted at Herbarium Bogoriense (BO), National Research and Innovation Agency (BRIN). Specimen identification was carried out using Backer & Bakhuizen van den Brink (1963), Gillespie (1993; 2007), and Cardinal-McTeague & Gillespie (2020). The description used terminologies from The Kew Plant Glossary (Beentje 2012), and the species name was validated at Plants of The World Online (2023). Collected specimens were deposited in UIDEP and FIPIA.

Key to the genus *Plukenetia* L. in Java

1. A. Basilaminar glands stipellate, styles connate into a depressed-globose column, the apex of fruit lobe have a central strap-shaped wing..... *P. corniculata* Sm.
- B. Basilaminar glands exstipellate, styles connate into a long cylindrical column, the apex of fruit lobe shortly horned and wingless..... *P. volubilis* L.

***Plukenetia volubilis* L.**, Sp. Pl.: 1192 (1753). *Sajorium volubile* (L.) Baill., Étude Euphorb.: 483 (1858). – TYPE: Plumier, Nov. Pl. Amer. t. 13, *Plukenetia* (1703); LT designated by Howard, Fl. Lessser Antilles 5: 82 (1989); cited by Gillespie, Syst. Bot. 18: 591 (1993). – Figure 1 & 2. *Fragariopsis paxii* Pittier, J. Washington Acad. Sci. 19: 351 (1929). – TYPE: Venezuela, Federal District, Loma de En Medio, Valley of Puerto

la Cruz, 1000 m, *Pittier 8109* (iso GH, US).

Plukenetia macrostyla Ule, Verh. Bot. Vereins Prov. Brandenburg 50: 80 (1908 publ. 1909). – TYPE: Brazil, Amazonas, Rio Jurua, near Jaburiu, *Ule 5864* (iso G).

Plukenetia peruviana Müll.Arg., Linnaea 34: 157 (1865). – TYPE: Peru, *Herb. Pavon* (syn G-DC, photo F 7111, G).

Perennial vine, monoecious, up to 4 m long, without milky latex. *Stems* twining, becoming woody, pubescent, green. *Stipules* minute, triangular, 2.5–3 × 1 mm, caducous, green. *Leaves* simple, alternate; petiole 5–8 cm long, pubescent, green; lamina cordate to deltate-ovate or lanceolate, 3–12.8 × 0.7–10 cm, base cordate or truncate to subcordate, margin serrulate to denticulate, with hydathodes, apex caudate-acuminate, acumen 1–4 cm long, chartaceous, adaxial surface pubescent, shiny green, abaxial surface pubescent, pale green, trinerved, veins scalariform, veinlets reticulate; basilaminar glands elliptic, 1.2–3 × 1–1.8 mm, exstipellate, yellowish green. *Inflorescences* axillary, racemose thyrses, up to 8 cm long, pubescent, bisexual, pistillate flower(s) basal, 1–3; staminate bracts narrowly triangular, ca. 1 mm long, pistillate bracts ovate, ca. 0.7 mm long, green; bracteoles 2 per flower, minute; flowers unisexual, actinomorphic, pedicellate, petals absent. *Staminate flowers*: 4–9.5 mm in diameter when open; pedicels ca. 1 mm long; sepals 5, valvate, lobe elliptic, ca. 2.2–4.5 × 1–2.5 mm, yellow; stamens (18–)19–21, free, ca. 0.5 mm long; filaments short, green; anthers 4-locular, basifixed, yellow; pistillode absent. *Pistillate flowers*: pedicels ca. 4–5 mm long; sepals 4, triangular, 10 × 7 mm, green; disc absent; ovary 4–5-locular, 1 ovule per locule, 4–5-lobed, lobes 6 mm long, pubescent, green; styles connate into a cylindrical column, up to 2 cm long, green; stigmas 4–5, rounded, ca. 2 mm wide, yellow. *Fruits* capsule, star-shaped, up to 6 cm wide, 4–5-locular, horned at the apex of each lobe. *Seeds* flattened, lenticular, 1.6–1.8 × 1.9–2 cm, dark brown, ecarunculate.

Distribution: The Lesser Antilles, Suriname, and the northern and western edges of the Amazon basin in Venezuela, Colombia, Ecuador, Peru, Bolivia, and Brazil (Gillespie 1993). In this paper, *P. volubilis* was collected from the cultivation area in Western and Eastern parts of Java (Figure. 1).

Habitat: It grows in disturbed regions or along forest edges at elevations up to 900 meters above sea level (Gillespie 1993). *Plukenetia volubilis* was found cultivated in open areas at 79–786 m asl on Java.

Specimens examined: INDONESIA. JAVA – **West Java** • Depok City, Beji, Pondok Cina, Universitas Indonesia Campus, Parangtopo Laboratory, 16.I.2023, *A Tianara AT-P-021* (UIDEP, FIPIA); Bandung Barat Regency, Ngamprah Subdistrict, Pakuhaji, 30.IV.2023, *ASD Irsyam 807* (FIPIA); Sumedang Regency, Rancakalong Subdistrict, Sukahayu Village, Nagrak, 01.V.2023, *ASD Irsyam 808* (FIPIA). – **East Java** • Malang Regency, Poncokusumo Subdistrict, Karanganyar Village, Karanganyar Kidul, Jl. Pancuran, 30.IV.2023, *MH Badlowi 04* (FIPIA).

Vernacular names: *Kacang inka* (Indonesian); *sacha inchi* (Quechua); *inca nut*, *inca peanut*, *sacha peanut* (English).

Uses: The species is frequently used to produce pharmaceutical, cosmetic, and dietary products (Blancke 2016; Wang et al. 2018; Torres Sánchez et al. 2021).

Plukenetia volubilis is found in the Lesser Antilles, Brazil, Bolivia, Peru, Ecuador, Colombia, Venezuela, and the Western and Northern edges of the Amazon basin. It typically grows in moist or wet lowland forests below 900 meters, along forest borders, or in disturbed areas (Gillespie 1993; Kodahl 2020; POWO 2023). A previous study revealed

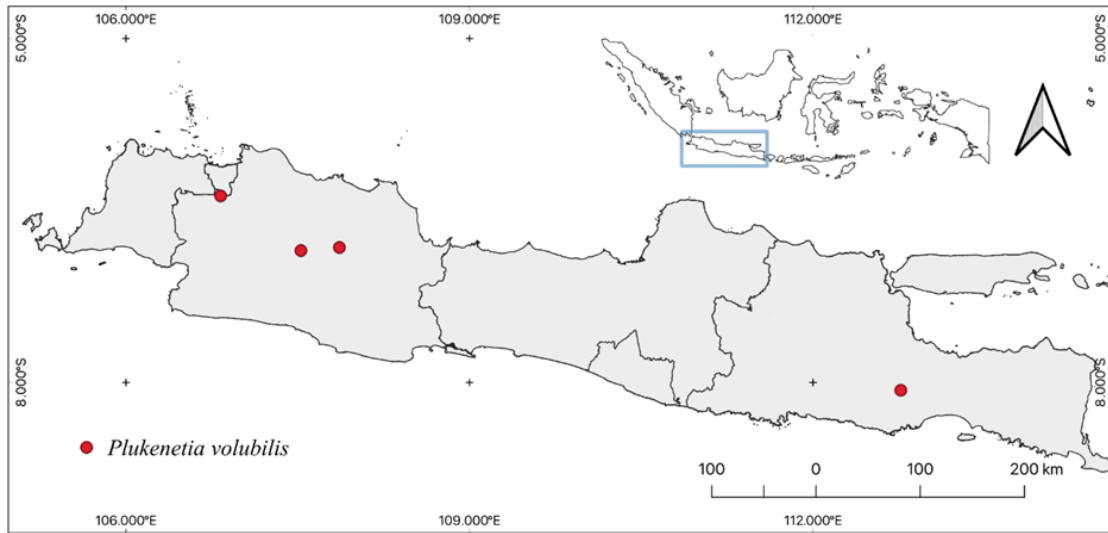


Figure 1. Distributions of *Plukenetia volubilis* in Java, Indonesia, collected from this study.

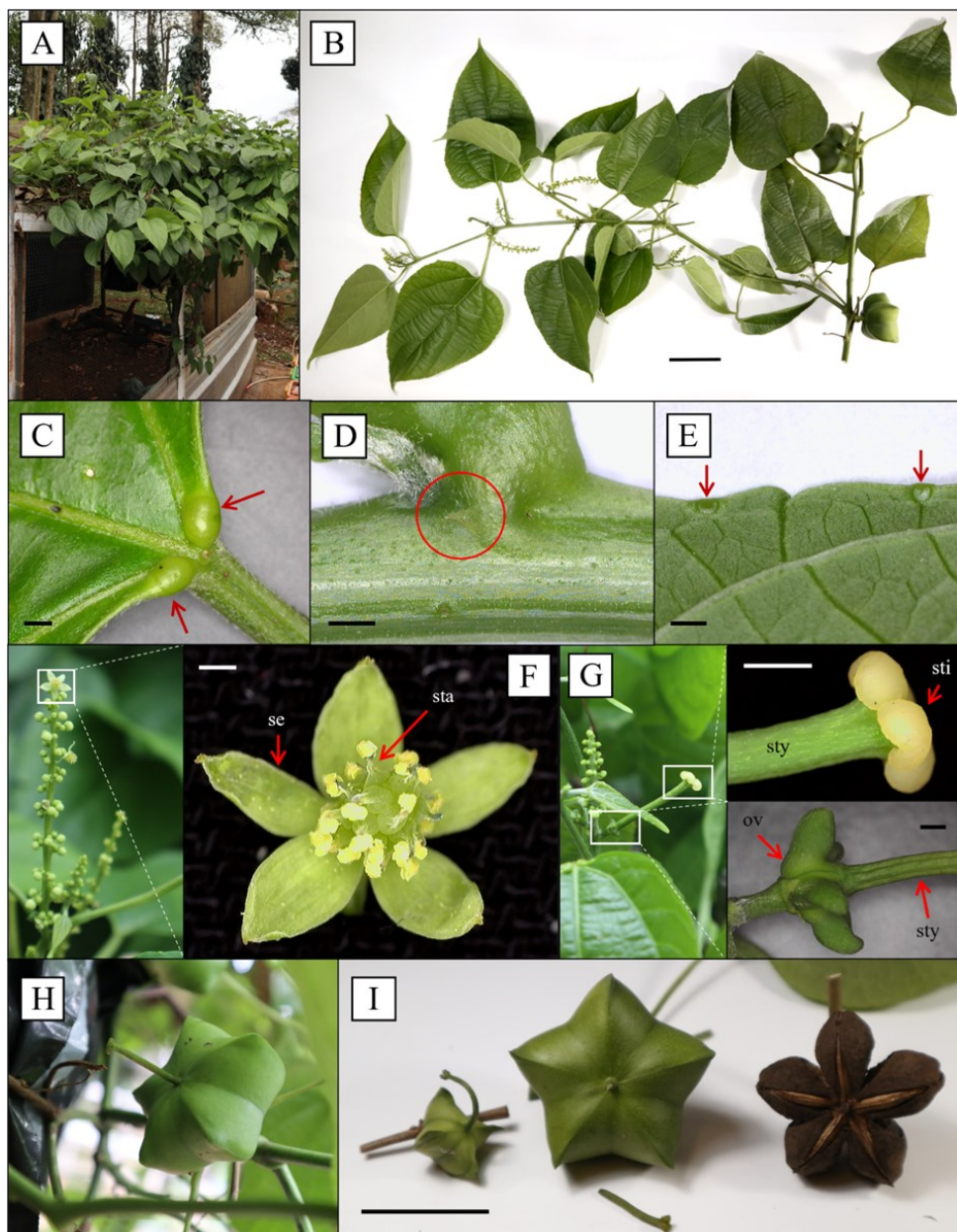


Figure 2. Morphological characters of *Plukenetia volubilis*. A-B. Habit; C. Adaxial basilaminar glands (arrows); D. Stipule (circled); E. Hydathodes (arrows); F. Staminate flower (se = sepal, sta = stamen); G. Parts of pistillate flower (sti = stigma, sty = style, ov = ovary, lobed); H. Fruit with pistil remnant; I. Development stages of fruit (young to old/dry; left to right). Scale bar = B. 5cm; C-F. 1mm; G. 2mm; I. 3cm.

that it had been recently introduced to Asia, such as China, Cambodia, Laos, and Thailand (Kodahl & Sørensen 2021). Previous botanists have not reported its occurrence in Java. *Plukenetia volubilis* is recorded for the first time for the Alien flora of Java in this paper. It was collected from West Java (Depok City, Bandung Barat Regency, and Sumedang Regency) and East Java (Malang Regency) at the cultivation area. Although, it is possible to find this species being cultivated elsewhere in Java. The history of its introduction to Java is not known. However, no specimens from Java were found during an examination at Herbarium Bogoriense (BO).

Our discovery increases the total number of *Plukenetia* in Java into two species, namely *P. corniculata* and *P. volubilis*. These two climbing species are quite similar to one another. *Plukenetia volubilis* differs from *P. corniculata*, a local species, based on the characteristics of the basillaminar glands, styles, fruit, and seeds. The morphological differences between those species are shown in Table 1.

Native South American communities have consumed seeds and leaves as a staple for at least three thousand years (Blancke 2016). Seeds of *P. volubilis* contain unsaturated fats, vitamins A, vitamins E, protein, essential amino acids, fiber, minerals, phenolic compounds, terpenoids, tocopherols, and phytosterols (Sathe et al. 2002; Blancke 2016; Kodahl 2020; Kodahl & Sørensen 2021; Torres Sánchez et al. 2021). The raw seeds are inedible and develop a nutty flavor after being roasted (Blancke 2016). The roasted seeds can be ground into flour, used to make butter, roasted and mixed with salt or sugar as a snack, or added to various traditional meals. In addition, many people blend salads or prepare tea with young leaves of *P. volubilis* (Flores 2010; Kodahl & Sørensen 2021).

Plukenetia volubilis has become more attention recently, especially because of the amount and composition of the seed oil. It is now possible to buy commercial items like oil and roasted seeds (Kodahl 2020). In Java, *P. volubilis* was known as *kacang inka* and has been cultivated for its leaves and seeds. In our study areas, the leaves are used for vegetables and tea, and the oil is extracted from the seeds. Moreover, previous studies showed that several ethnic groups in Peru have used seed oil of *P. volubilis* for centuries to rejuvenate and revitalize the skin, alleviate rheumatism, relieve muscle pain, and heal bug bites (Flores & Lock 2013; Gonzalez-Aspajo et al. 2015; Kodahl & Sørensen 2021). Pharmacological studies revealed that seed oil has potential in the cosmetics industry as an emollient (softening and smoothing skin), humectant, anti-aging, antioxidant, and penetration enhancer (Brinckmann 2013; Soimee et al. 2019;

Table 1. Morphological differences between *Plukenetia corniculata* and *P. volubilis*.

Morphological characters	<i>P. corniculata</i> (WFO 2023)	<i>P. volubilis</i>
Petiole	Moderately or sparsely pubescent	Pubescent
Lamina	Ovate, oblong-ovate, or sometimes elliptic	Cordate to deltate-ovate or lanceolate
Leaf margin	Serrulate or serrate	Serrulate to denticulate
Venation	Weakly palmate, nerves 2–4	Trinerved
Basillaminar glands	Stipellate	Exstipellate
Style	Connate into a depressed-globose column	Connate into a long cylindrical column
Apex of fruit lobe	Having a central strap-shaped wing	Shortly horned and wingless
Seed	Broadly lenticular and laterally compressed	Lenticular and flattened
Seed color	Cream, pale orangish-brown or brown	Dark brown

Poomanee et al. 2021; Maya & Sriwidodo 2022). The seed oil also has some biological activities, including antihypertensive, anticancer, anti-hypercholesterolemia, antimicrobial, and reduces the risk of stroke (Gonzalez-Aspajo et al. 2015; Wang et al. 2018; Silalahi 2022).

AUTHOR CONTRIBUTION

AT and ASDI designed the research. AT, WH, ASDI, MRH, MHB, P, and APD collected the plant materials, observed the specimen, and analyzed the data. AT, WH, ASDI, MRH, MHB, APD, P, DR, and MA wrote the original draft and agreed to the final manuscript.

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CONFLICT OF INTEREST

All authors declare no conflict of interests.

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