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Zamioculcas zamiifolia (Araceae), an African Species Cultivated in Cuba

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Abstract

Context: The presence of a non-identified taxon, which has the general characteristics of family *Araceae*, in cultivation found in Camagüey province, calls for the need to specify some of its taxonomical and cultural aspects.
Aim: to reveal the nomenclature, taxonomical position, and taxon description, as well as its singularities and corroborated and potential usefulness within family *Araceae* are discussed.
Methods: Specimens observed in Camagüey city gardens were studied, using botanical methods of research, such as collecting, catalogue and key use, and description and scientific illustrations.
Results: The nomenclature of the plant was determined, the taxon was described, and an analytical key was suggested for contrasting this species from the other Cuban araceae. Aspects related to its corroborated usefulness for air purification, and its potential significance in medicine and nutrition, were discussed.
Conclusions: *Zamioculcas zamiifolia* (Lodd.) Engl. will hereupon be considered in catalogs and specialized publications on Cuban flora. The potential of *Z. zamiifolia*, for improvements of air quality, and the antioxidant and cytotoxic effects of the plant, offer an interesting perspective for further management of this phytogenetic resource, which deserves to be studied in the Cuban context.

Key words: Zamioculcadeae, Aroideae, Camagüey flora, Cuban flora, ornamental plants.

Introduction

An exotic taxon is cultivated in the province of Camagüey, which responds to the general characteristics of family *Araceae*. The plantlets are sold by the agricultural sector in the territory, as a way to improve the city gardens. A preliminary analysis reveals the possibility of a not previously recorded taxon in the scientific literature of Cuba. Additionally, some of the morphological characters are similar to the ones of genus *Zamioculcas*, whose only representative is Zamioculcas zamiifolia (Lodd.) Engl. known in other countries as "money plant" or "luck plant". This species is widely used to decorate interiors (Chen, Henny & McConnell, 2002), and it is popular by growers and buyers (Chen & Henry, 2003). Moreover, some studies of its properties to improve air quality have been conducted (Zhou, Qin, Su, Liao & Xu, 2011), as well as its cytotoxic and antioxidant effects (Muharini, Masriani & Rudiyansyah, 2018).

This contribution responds to the request made by one of the above-mentioned entities, Herbarium Julian Acuña Gale (HIPC), to determine its identity. In the communities surrounding the city of Camagüey where it is cultivated, the poor knowledge of the plant was remarkable, due to the absence of a common name that would facilitate search in the literature, both within this botanical family and as part of plant resources used in gardening. What was initially a simple scientific service, due to the features expressed, ended up in a formal research task, requiring deeper knowledge, and the use of methods pertaining to botanical sciences.

In this paper, the nomenclature, taxonomical position, and taxon description are disclosed, and its main

singularities, as well as corroborated and potential usefulness within family *Araceae*, are discussed.

Materials and Methods

This study is part of one of the task of an institutional research program (Contribution to Knowledge and Sustainable Management of Groups Selected from Camagüeyan Biodiversity), developed by the Center for Environmental Studies, at Ignacio Agramonte University of Camagüey. Reflections linked to plant chemistry and usefulness of the taxon also contribute to the project *Installing a Center of Excellence in the Central-Eastern Region of Cuba to Enhance Production and Research of Bioactive Plants*, a collaboration between Cuban and Belgium universities, funded by the VLIR-OUS program from the Council of Flamingo Universities.

An *in situ* study was done consisting of collecting digitalized images, and the morphological evaluation of plants, in reference to vegetative and reproductive structures, along with an evaluation of resistance to water stress, performance under little light conditions, and certain phenological aspects. To achieve that, a specimen was planted at the Teaching Laboratory of Microbiology, Faculty of Applied Sciences, Ignacio Agramonte University of Camagüey. A representative sample from the plant was herborized, which was later added to the collection of Julian Acuña Gale herbarium, from the facility (HIPC, Jose Marti Higher Pedagogical College). Measurements were performed using a tape measure and caliper gauge. Moreover, observations and measurements of plants where the propagation material was obtained, in order to be sold by the Provincial Soil Laboratory of Camagüey.

The species was identified through comparison of descriptors, keys, and images found in Chen, Henry & McConnell (2002), Chen & Henry (2003), Heng, Guanghua, Boyce, Murata, Wilbert, Hetterscheid, Bogner & Jacobsen (2005), Díaz-Jiménez, Guadarrama-Olivera & Croat (2015). Specimens of digital herbariums were consulted as well, from B (Botanischer Garten und Botanisches Museum Berlin-Dahlem, Zentraleinrichtung der Freien Universität Berlin), MO (Missouri Botanical Garden), K (Royal Botanic Gardens, Kew), and PRE (South African National Biodiversity Institute), whose access was facilitated by JSTOR http://plants.jstor.org, EOL http://eol.org, Tropicos http://www.tropicos.org y Kew Royal Botanic Gardens http://www.kew.org. Information was also consulted from these sites: Global Biodiversity Information Facility https://www.gbif.org, NCBI http://www.ncbi.nlm.nih.gov and BHL http://www.biodiversitylibrary.org. The Font Quer (2001) terminology was used for description.

The search for possible documentary evidence of its presence in Cuba included the review of material deposited in herbariums: HAC, HAJB (National Botanical Garden. University of Havana), HIPC (Jose Marti Higher Pedagogical College, herbarium University of Camagüey), and ULV (Marta Abreu Central University of Las Villas), along with the bibliographic review.

Results and discussion

The application of the above-mentioned methods demonstrated that this plant belongs to genus *Zamioculcas* Schott, family Araceae, subfamily Aroideae, tribe Zamioculcadeae. This is a monotypic genus, whose only known species is Zamioculcas zamiifolia (Lodd.). Engl. originally from Africa.

Initially, this plant was described by George Loddiges (1784-1846) under the name *Caladium zamiifolium* Lodd., in 1828. Later, in 1856, Heinrich Wilhem Schott (1794-1865) concluded that it had enough traits so as to move it from *Caladium* Vent. to a separate genus, which he called *Zamioculcas* Schott (*Z. loddigesii*). In 1905, Heinrich Gustav Adolf Engler (1844-1930) established the current nomenclature of the species (*Z. zamiifolia).*

The data referring to its nomenclature, description, distribution, etnobotany, and performance in Cuba are the following:

Zamioculcas H. W. Schott Syn. Aroid. 71.1856.

Type: *Z. loddigesii* H. W. Schott, *nom. illeg* (*Caladium zamiaefolium* Loddiges, *Z. zamiifolia* (Loddiges) Engler).

Only one species native to Africa, and cultivated in different parts of the world.

Zamioculcas zamiifolia (Lodd.) Engl. Niedenzu in Engler, Pflanzenreich 4. 141 (Heft 91).1928 ≡ *Caladium zamiifolium* Lodd. Bot. Cab. 15: t. 1408. 1828. Lectotype (herein designed): figure 1408, Cocke in Bot. Cab. 1828. Fig. 1.

=*Zamioculcas loddigesii* H. W. Schott Syn. Aroid. 71.1856.

=*Zamioculcas laneolata* Peter Nachr. Ges. Wiss. Göttingen, Math. Phys. Kl: 211. 1929. Holotype Mozambique, Beira, 5-X-1925, *Peter* 31194 (B #100165447 [photo!], isotypo K [n.v.].

Perennial, herbaceous, diclino-monoecious plant. Underground, horizontal rhizomes, with variable sizes according to age; 0.4-10 cm or bigger after 2 years. Alternate, pinnate, persistent leaves, growing from rhizomes; erect, thick, 60 cm long petioles, with remarkable swelling on the base, in pale-green-grayish color, slightly spotted in darker green occasionally; 6-8 pair, alternate to subopposite, and ovate-elliptic to lanceolate folioles (10-15 x 7-8 cm),

bright and glabrous on either surface, thick, with dark green face (slightly lighter when young), paler leaf back, entire leaf margin, 8-10 pair veins, slightly printed on the face. Spadix of up to 6 cm long, cylindrical, thick, the top covered with functionally male flowers, and the lower side with female flowers, separated by a narrow strip of completely sterile flowers, pale green oval spathe, of up to 7x3 cm. Undifferentiated perianth (perigonial), with four cuneate or spatulate, concave tepals depressed on the apex. Higher flowers with 4 stamens; short, slightly broadened filaments in the apex, compressed, theca ovate to elliptic; short oblong, well developed ovaries, though not longer than the tepals. Intermediate flowering with claviform pistils inside the perigone. Lower flowering without stamens, with well-established pistils whose stigma is longer than the tepals. White, compressed globous 1.2 cm diameter berries, shrunk in the septum. Ellipsoidal seeds, almost without endosperm (just as some cellular layers at the end of chalaza), large and starched embryo. Fl. and Fr. XII-III.

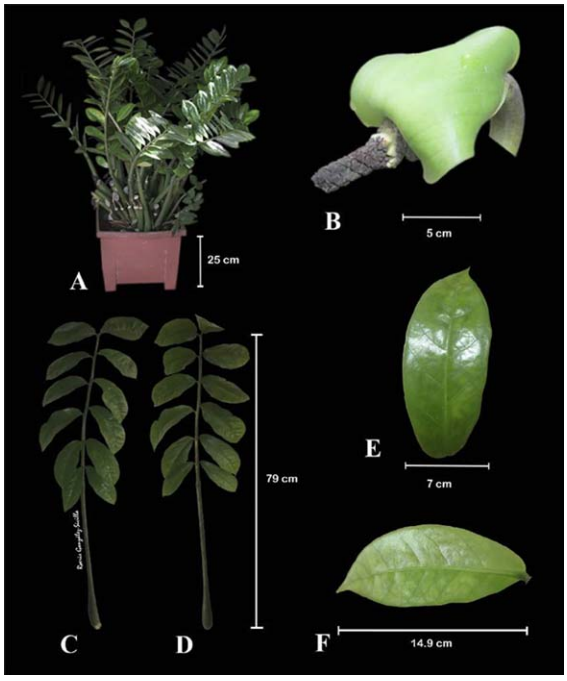

Fig. 1. *Zamioculcas zamiifolia* (Lodd.) Engl. photos Isidro Eduardo Méndez Santos and Roeris González-Sivilla. Photographic composition: Roeris González-Sivilla. A- *Z. zamiifolia* growing in a 0.016 m^3 pot (25 x 25 x 25 cm). B- inflorescence. C- leaf (face). D- leaf (back). E- foliole (face). F- foliole (back).

Native to southeast Africa, from Kenia to northeast South Africa (Chen & Henry, 2003). Its cultivation has spread throughout the world considerably, as a complement to office furniture, halls, and other rooms.

In 2002, the Florida Nursery, Growers and Landscape Association (FNGLA) acknowledged *Z. zamiifolia* as the Plant of the Year in Florida (Chen & Henry, 2003). It has been often shown in botanical gardens worldwide.

This plant has been cultivated in Camagüey, where it is propagated, cultivated, and sold by the Provincial Soil Laboratory from the Ministry of Agriculture. Reliable references have been collected of the presence of this plant in Santiago de Cuba, Guantánamo, and Villa Clara.

No common names have been generalized in Cuba. One of the most dedicated gardeners in Santa Clara city claims that his plant is known as the plant of Che Guevara, because it is very abundant in the gardens around the monument to Guevara de la Serna (J. C. Montero Rodríguez, personal communication, February 8, 2019). Internationally, it has been named as ZZ plant, Zanzibar Gem, Zuzu plant, aroid palm, eternity plant or emerald palm (Chen & Henry, 2003; Chen, Henny & McConnell, 2002; Heng, Guangghua, Boyce, Murata, Wilbert, Hetterscheid, Bogner & Jacobsen, 2005; Díaz-Jiménez, Guadarrama-Olivera, and Croat, 2015; Earth.com, 2019).

Chromosomal number: 2n= 34 (Marchant, 1973; Bogner, 2001).

Specimens observed: Camagüey, Ignacio Agramonte Loynaz University (21°22´08.8 N – 77°54´08.4 W), cultivated in pots, IV-2019, R. González, HPC-12184 (HIPC).

Besides being an ornamental plant, the potential of the plant for interior design and utilization for feng shui practice has been studied (Chen, Henny & McConnell, 2002). No references of its use for animal or human nutrition have been found, though studies should be done in this direction, due to its antioxidant values (Muharini, Masriani & Rudiyansyah, 2018).

Research refers to the potential of *Z. zamiifolia*'s metabolic activity to remove polluting indoor gases from the air. In that sense, the experiments performed by Zhou, Qin, Su, Liao & Xu (2011), Sriprapat & Thiravetyan (2013), Sriprapat, Boraphech & Thiravetyan (2014), Toabaita, Vangnai & Thiravetyan (2016), Khaksar, Treesubsuntorn & Thiravetyan (2017), to remove benzene, toluene, ethyl benzene, and xylene, are remarkable.

In the area of bioactive production for medical purposes, there is documented evidence of the promising applications of the plant's root extracts in oncology, due to the antioxidant and cytotoxic effects observed in experiments (Muharini, Masriani & Rudiyansyah, 2018).

Zamioculcas zamiifolia is not recorded in the West Indies by Acevedo & Strong (2012), regardless of the fact that in 2018 and 2019, it was observed on different locations of the Dominican Republic by one of the authors of this paper. The plant is not recorded either in the most relevant catalogs of Cuban flora (De la Sagra, 1845, 1850; Grisebach, 1860, 1864, and 1866; Sauvalle, 1873; Gómez de la Maza, 1889, and 1897; Gómez de la Maza & Roig, 1914; Agete, 1939;

Seifriz, 1943; Anonymous, 1958; Roig, 1965; Boldo & Estévez, 1990; Esquivel, Knüpffer & Hammer, 1992; Herrera, 1993; Oviedo, 1994; Greuter & Rankin, 2017). Additionally, no herborized specimens were found in HAC, HIPC, and ULV.

When the presence of *Zamiolculcas* was corroborated in Cuba, it was contrasted from different Araceae genera recorded in the country by Arias (1998) and Greuter & Rankin (2017), according to this analytical key:

1 Aquatic, floating, and free plants. Subsessile, spongy leaves. Pauciflora spadices.....*Pistia*
1* Ground, saxicola, creeping, epiphytic or hemiepiphytic plants Petiolate, non-spongy leaves. Multiflora spadices.....2
2 Composite, pinnate leaves.....Zamioculcas
2* Simple, sometimes pinnatisect leaves, but not completely incised.....3
3 Basically aerial stems, either erect or creeping, sometimes with a subterranean part that may produce feculent modifications (rhizomes or tubers), but clearly differentiated from the aerial part.....4
3* Basically underground stem, sometimes a part emerges from the ground (occasionally in a prominent manner), but clearly differentiated from the underground part..... 13
4 Erect stems, with or without visible adventitious roots (when present not adhesive)..... ...5
4* Creeping stems through adventitious roots..... 7
5 Solid green, pinnately divided foliar sheets.....*Philodendron*
5* Entire Solid green or yellow and white variegated foliar sheets..... ...6
6 Solid green, ascending, corded foliar sheets, adult, 20 cm width or more.....*Alocasia*
6* Yellow and white variegated foliar sheets; ovate, oblong-ovate or narrowly oblong-elliptical to linear, generally less than 20 cm width.....7
7 Ovate, oblong-ovate foliar sheets, with over 10 cm width.....*Dieffenbachia*
7* Narrowly oblong-elliptical to linear foliar sheets, less than 10 cm width.....*Aglaonema*
8 Stems with whitish longitudinal, prominent, and irregular crests…….....*Epipremnum*
8* Flat stems without whitish longitudinal, prominent, and irregular crests.....9
9 Fenestrated, pinnatifidus foliar sheets (at least when adult).....*Monstera*
9* Pedatilobate or entire, non-fenestrated foliar sheets (at least in Cuban species).....10
10 Pedatilobulated foliar sheets (at least in adult plants), with reticulated veins between the primary lateral veins.....*Syngonium*
10* Simple, entire, lobate, variably divided or pinnatifidus foliar sheets, but never pedatilobulated, even when adult.....11
11 Silver spot variegated foliar sheets.....*Monstera*
11* Evenly colored green foliar sheets.....12
12 Leaves with parallel second order nerves (lateral).....*Philodendron*
12* Leaves with reticulate second order nerves (lateral).....*Anthurium*
13 Pelted leaves.....14
13* Non-pelted leaves..... 15
14 Fresh red petiole; foliar sheets of up to 20 cm wide, with spots of several colors (generally red, white, and yellow).....*Caladium*
14* Fresh green petioles; foliar sheets of up to 40 cm wide or over, unevenly green.....*Colocasia*
15 Entire elliptical, foliar sheets attenuated at the base. White spathes when young, which get different green shades when mature.....*Spathiphyllum*
15* Pedatisect or entire, but never elliptical, foliar leaves, corded at the base. Spathes of a different color.....16
16 Adult plants with part of the stem in epigeal position (emerging from the ground, occasionally in a prominent manner), but clearly differentiated from the underground part.....17
16* Plants with totally hypogeal stems (no part of the stem is above the ground even when adult)..... 19
17 Short part of the stem is emerged, with several adventitious roots. Conspicuously coriaceous foliar sheets.....*Anthurium*
17* Part of the stem has emerged due to age, generally without many adventitious roots. Membranaceous to slightly coriaceous foliar sheets.....18
18 Sagittate foliar sheets with the apex tilted toward the ground and ascending basal lobules.....*Xanthosoma*
18* Corded, ascending foliar sheets.....*Alocasia*
19 Plants growing in flooded spaces; ascending leaves.....*Peltandra*
19* Plants growing in non-flooded spaces; horizontal leaves with apex tilted toward the ground.....20
20 Pedatisect or entire leaves with foliar sheets bearing long whitish spots.....*Xanthosoma*

20 * Ever-entire leaves with evenly colored green foliar sheets.....21
21 Coriaceous foliar sheets.....*Anthurium*
21 * Membranaceous foliar sheets.....*Typhonium*

There is no evidence of the manner and date of introduction of *Zamioculcas zamiifolia* in Cuba. However, the sustained trend to exoticism in gardening, since ancient times to present, (Santiago, 2008; Brennan, 2011), and easy propagation of cultivation (Chen & Henry, 2002; Seneviratne, Daundasekera, Kulasooriya & Wijesundara, 2013), are the most probable causes that led to the introduction of the plant.

Conclusions

Zamioculcas zamiifolia (Lodd.) Engl. has spread in Cuba with mainly ornamental purposes; hence, it should hereupon be considered in catalogs and specialized publications of the Cuban flora.

The existing references on the potential of *Z. zamiifolia* to improve air quality, and the antioxidant and cytotoxic effects, offer an interesting perspective for further management of this phytogenetic resource, which deserves to be studied in the Cuban context.

Author contribution

Roeris González-Sivilla: research planning, bibliographic review, creation of the analytical key, analysis of results, manuscript redaction, final review.

Isidro E. Méndez Santos: research planning, creation of the analytical key, analysis of results, manuscript redaction, final review.

Conflicts of interests

No conflict of interest has been declared.

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References

Acevedo Rodríguez, P., & Strong, M. T. (2012). *Catalogue of seed plants of the West Indies.* Washington D.C.: Smithsonian Institution Scholarly Press. Retrieved on May 12, 2019, from: https://repository.si.edu/bitstream/handle/10088/17551/SCtB-0098.pdf?sequence=2&isAllowed=y

Agete, F. (1939). Floricultura cubana. *Revista de Agricultura,* 5 (1), 1582-1603.

Anonymous. (1958). *Flowering plants from Cuban Gardens.* La Habana: Seoane, Fernández y Cía.

Arias, I. (1998). Araceae. Fascículo 1 (1). En H. Manitz, (Ed.), *Flora de la República de Cuba. Serie A Plantas Vasculares. Fascículo 1 Araceae Aristolochiaceae Bombacaceae Droseraceae Linaceae.* Koeningstein, Federal Republic of Germany: Koeltz Scientific Books.

BHL. (2019). *Bibliography for Zamioculcas zamiifolia (Lodd.) Engl. by Page.* Retrieved on November 23, 2019, from: https://www.biodiversitylibrary.org/name/Zamioculcas_zamiifolia_(Lodd%24)_Engl%24

Bogner, J. (2001). Araceae. En U. Eggli (ed.), *Illustrated Handbook of Succulent Plants: Monocotyledons* (pp. 229-230). Berlin: Springer-Verlag.

Boldo, B., & Estévez, J. (1990). Cubensis prima flora. *Fontqueria,* 29, 19-176.

Brennan, J. (2011). *Do potted-plants improve the indoor environment?* (Thesis in fulfilment of the requirements for the degree of Master of Science), University of Technology, Sydney, Australia) Retrieved on November 20, 2018, from: https://opus.lib.uts.edu.au/bitstream/10453/29854/1/01Front.pdf

Chen, J., Henny, R. J., & McConnell, D. B. (2002). Development of New Foliage Plant Cultivars. En J. Janick and A. Whipkey (eds.), *Trends in new crops and new uses.* (pp. 466-472). Alexandria, United States of America: ASHS Press. Retrieved on September 9, 2019, from: https://hort.purdue.edu/newcrop/ncnu02/pdf/chen.pdf

Chen, J., & Henry, R. J. (2003). ZZ: A Unique Tropical Ornamental Foliage Plant. *HortTechnology, 13* (3), 458-462. Doi: https://doi.org/10.21273/HORTTECH.13.3.0458

De la Sagra, R. (1845). *Historia física, política y natural de la isla de Cuba.* (Pt. 2, Tomo X). París: Librería de Arthus Bertrand. Retrieved on November 10, 2019, from: https://bibdigital.rjb.csic.es/medias/9b/6e/35/f5/9b6e35f5-0da0-401f-9a6b-9066f27c0d8c/files/SAG_Hist_10.pdf

De la Sagra, R. (1850). *Historia física, política y natural de la isla de Cuba.* (Pt. 2, Tomo XI). París: Librería de Arthus Bertrand. Retrieved on November 10, 2019, from: https://bibdigital.rjb.csic.es/medias/74/35/2d

/fd/74352dfd-05c8-496b-a27d-50516fc93908/files/396.pdf

Díaz-Jiménez, P., Guadarrama-Olivera, M. A., & Croat, T. B. (2015). Diversidad florística de Araceae en el Estado de Tabasco, México. *Botanical Sciences, 93* (1), 131-142. Retrieved on October 20, 2019, from: http://www.scielo.org.mx/pdf/bs/v93n1/v93n1a11.pdf

Earth.com. (2019). *Zamioculcas zamiifolia (Emerald plant)*. Retrieved on March 21, 2019, from: https://www.earth.com/earthpedia/plant/emerald-palm/

EOL. (2019). *Zz Plant Zamioculcas zamiifolia (G. Lodd.) Engl.* Retrieved on February 23, 2019 from Encyclopedia of life Web site. Retrieved on March 22, 2019, from: https://eol.org/pages/1127680

Esquivel, M. A., Knüpffer, H., & Hammer, K. (1992). Inventory of the Cultivated Plants. En K. Hammer, M. A. Esquivel, & H. Knüpffer, *"...y tienen taxones y fabas muy diversos de los nuestros..." Origin, Evolution and Diversity of Cuban Plant Genetic Resources Volume 2 Chapter 14* (pp. 213-454). Germany: Institutfür Pflanzengenetik und Kulturpflanze forschung Gatersleben.

Font Quer, P. (2001). *Diccionario de Botánica.* (2da ed.). Barcelona: Península.

Global Biodiversity Information Facility. (2019). *Zamioculcas zamiifolia*. Retrieved on November 14, 2019, from: https://www.gbif.org/species/2869014

Gómez de la Maza, M. (1889). *Diccionario botánico de los nombres vulgares cubanos y puertorriqueños.* La Habana: Impr." La Antilla" de G. Cacho-Negrete.

Gómez de la Maza, M. (1897). *Flora Habanera. Fanerógamas.* La Habana: Imp. La Moderna Poesía.

Gómez de la Maza, M., & Roig, J. T. (1914). Flora de cuba (datos para su estudio). *Boletín de la Estación Experimental Agronómica de Santiago de las Vegas,* (22). Imprenta y Papeleria de Rambla, Bouza y ca.

Greuter, W., & Rankin, R. (2017). *Plantas vasculares de Cuba Inventario preliminar Segunda edición, actualizada, de Espermatófitos de Cuba con inclusión de los Pteridófitos.* Berlin: Botanischer Garten und Botanisches Museum Berlin, doi: https://doi.org/10.3372/cubalist.2017.1

Grisebach, A. (1860). *Plantae wrightianae e Cuba orientali.* Cantabrigiae Nov. Angl.: [American Academy of Arts and Sciences], doi: https://doi.org/10.5962/bhl.title.708

Grisebach, A. (1864). *Flora of the British West Indian Islands.* London: Lovell Reeve, doi: https://doi.org/10.5962/bhl.title.106964

Grisebach, A. (1866). *Catalogus plantarum cubensium,* exhibens collectionem Wrightianam aliasque minores ex insula Cuba missas Lipsae: Apud Gulielmum Engelmann, doi: https://doi.org/10.5962/bhl.title.177

Heng, L., Guanghua, Z., Boyce, P. C., Murata, J., Wilbert, L., Hetterscheid, A., Bogner, J. & Jacobsen, N. (2005). Araceae. En *Flora of China.* (Vol. 23, pp. 3-79). China and USA: Science Press (Beijing) & Missouri Botanical Garden (St. Louis). Retrieved on May 12, 2018, from: http://flora.huh.harvard.edu/china/mss/volume23/Flora_of_China_Vol_23_Araceae.pdf

Herrera, P. (1993). Sobre la protoflora cubana, cubensis prima flora, y el herbario de Boldo y Estévez. *Fontqueria, 36*, 147-191.

JSTOR. Global Plants. (2018). *Zamioculcas zamiifolia*. Retrieved on January 17, 2019, from: https://plants.jstor.org/search?filter=name&so=ps_group_by_genus_species+asc&Query=Zamioculcas+zamiifolia

Kew Royal Botanic Gardens. (2018). *Herbarium Catalogue: Specimen 45220.000.* Retrieved on July 20, 2018, from: https://specimens.kew.org/herbarium/45220.000

Khaksar, G., Treesubsuntorn, Ch., & Thiravetyan, P. (2017). Effect of exogenous methyl jasmonate on airborne benzene removal by *Zamioculcas zamiifolia*: The role of cytochrome P450 expression, salicylic acid, IAA, ROS and antioxidant activity. *Environmental and Experimental Botany, 138* (6), 130-138. doi: https://doi.org/10.1016/j.envexpbot.2017.03.007

Loddiges, C. (1828). *The Botanical Cabinet Consisting of Coloured Delineations of Plants from all Countries* (Vol. XV). London: John & Arthur Arch, Cornhill - Lougman, Reea Orme, Brown & Green, Taternoster Row - C Loddiges & Sons, Hackney.

Marchant, C. J. (1973). Chromosome variation in Araceae: V. Acoreae to Lasieae. *Kew Bulletin, 28* (2), 199-210, doi: http://dx.doi.org/10.2307/4119780

Muharini, R., Masriani, M., & Rudiyansyah, R. (2018). Phytochemical screening, antioxidant, and cytotoxicity of *Zamioculcas zamiifolia* root extract. *Indonesian Journal of Pure and Applied Chemistry, 1* (2), 62-67, doi: http://dx.doi.org/10.26418/indonesian.v1i2.30530

NCBI. (2019). *Nucleotide.* Retrieved on November 5, 2019, from:

https://www.ncbi.nlm.nih.gov/nuccore/?term=Zamioculcas+zamiifolia

Oviedo, R. (1994). Plantae wriaghtianae ex insula Cuba quae in herbario horti regii matritensis asservantur. *Fontqueria, 39*, 165-213.

Roig, J. T. (1965). *Diccionario botánico de nombres vulgares cubanos.* (Vol. 2). La Habana, Cuba: Editora del Consejo Nacional de Universidades.

Santiago, J. (2008). *La naturaleza en la ciudad: perspectivas teóricas y metodológicas para el estudio de la funcionalidad ambiental del espacio libre.* Sevilla, España: Consejería de Obras Públicas y Transportes. Retrieved on November 5, 2019, from: https://ws147.juntadeandalucia.es/obraspublicasyvivienda/publicaciones/07%20PAISAJE%20Y%20TERRITORIO/la_naturaleza_en_la_ciudad/la_naturaleza_en_la_ciudad.pdf

Sauvalle, F. A. (1873). *Flora cubana. Enumeratio nova plantarum cubensium vel revisio catalogi Grisebachaini. Exhibens Descriptiones Generum Specierumque Novarum Caroli Wright Et Francisci Sauvalle, Synonymis Nominibusque Vulgaribus Cubensis Adjectis.* La Habana: Havanæ, Imp. "La Antilla," de Cacho-Negrete, doi: https://doi.org/10.5962/bhl.title.51954

Seifriz, W. (1943). Theplantlife of Cuba. *Ecological Monographs, 13*: 375-426.

Seneviratne, K. A. C. N., Daundasekera, W. A. M., Kulasooriya, S. A., & Wijesundara, D. S. A. (2013). Development of Rapid Propagation Methods and a Miniature Plant for Export-oriented Foliage, *Zamioculcaszamiifolia*. *Ceylon Journal of Science (Bio. Sci.), 42* (1), 51-62, doi: 10.4038/cjsbs.v42i1.5899

Sriprapat, W., Boraphech, P., & Thiravetyan, P. (2014). Factors affecting xylene-contaminated air removal by the ornamental plant *Zamioculcas zamiifolia*. *Environmental Science and Pollution Research, 21* (4), 2603-2610, doi: https://doi.org/10.1007/s11356-013-2175-y

Sriprapat, W., & Thiravetyan, P. (2013). Phytoremediation of BTEX from indoor air by *Zamioculcas zamiifolia*. *Water Air Soil Pollut, 224* (3), 1-9, doi: https://doi.org/10.1007/s11270-013-1482-8

Toabaita, M., Vangnai, A.S., & Thiravetyan, P. (2016). Removal of ethylbenzene from contaminated air by *Zamioculcaszamiifolia* and microorganisms associated on Z. zamiifolia leaves. *Water Air Soil Pollut, 227* (4), 11-21, Art. 115 doi: https://doi.org/10.1007/s11270-016-2817-z

Tropicos. (2019). *Zamioculcas zamiifolia* (Lodd.) Engl. En *Tropicos.org.* Retrieved on June 20, 2019, from: http://www.tropicos.org/Name/2104727

Zhou, J., Qin, F., Su, J., Liao, J., & Xu, H. (2011). Purification of formaldehyde-polluted air by indoor plants of Araceae, Agavaceae and Liliaceae. *Journal of Food, Agriculture & Environment* 9 (3 & 4), 1012-1018. Retrieved on November 12, 2019, from: https://www.researchgate.net/publication/231184098_Purification_of_formaldehyde-polluted_air_by_indoor_plants_of_Araceae_Agavaceae_and_Liliaceae