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On Genus *Amorphophallus* Blume ex Decne (Araceae) in Cuba

Roeris González-Sivilla[1] & Isidro E. Méndez Santos[2]

[1]ORCID https://orcid.org/0000-0002-9877-2070, Ignacio Agramonte Loynaz University of Camagüey, Department of Education Biology, Camagüey, Cuba, [2]ORCID https://orcid.org/0000-0002-0437-8057, Ignacio Agramonte Loynaz University of Camagüey, Center for Environmental Studies, Camagüey, Cuba.

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Email: roeris.gonzalez@reduc.edu.cu

Abstract

Context: The presence in several Cuban cities of *Amorphophallus* Blume ex Decne (Araceae), which has been poorly and unelaborately published in the scientific literature, encouraged researchers to conduct a systematic, phytogeographic, and ethnobotanical study of this plant.
Aim: To unveil the nomenclature, taxonomy, phenotypical characterization, differences from akin taxons, distribution, and usefulness of specimens of *Amorphophallus* Blume ex Decne, currently cultivated in Cuba outside scientific collections.
Methods: Specimens kept in gardens of the city of Camagüey were studied using methods such as collection work, descriptor and key comparisons, and scientific description and illustration.
Results: The presence in Cuba of genus Amorphophallus Blume ex Decne was confirmed, proving that it is related to other three species: *A. paeoniifolius* (Dennst.) Nicolson, *A. konjac* K. Koch, and *A. titanum* (Becc.) Becc. ex Arcang. The determination of the nomenclature was determined more accurately; the genus and other two species were described. Besides, the analytical key was adjusted to contrast the different Araceae genuses present in the country; another key was presented to contrast the two species described. Aspects related to their usefulness (corroborated or potential) were discussed from different perspectives: food and medicinal properties, and as a nutritional enhacer of soil.
Conclusions: Amorphophallus Blume ex Decne, denoted at least as *A. paeoniifolius* (Dennst.) Nicolson and *A. konjac* K. Koch, given their frequent cultivation as ornamental plants in Cuba, which from now on must be included in the specialized catalogs and publications related to the flora of the country. The potentialities for sustainable management of species were identified.

Key words: *Thomsonieae, Aroideae, Cuban flora, Camagueyan flora, exotic plants.*

Introduction

In May 2019, during a theoretical and practical meeting scheduled as part of discipline Work-Research Education, students of the second year of the Degree in Biology Education, at the Ignacio Agramonte Loynaz University, observed the inflorescence of a plant with particular features, without visible vegetative structures, growing in a public green area in the Camagueyan neighborhood of Vigia.

Accordingly, the main teachers of the Degree requested a taxonomic determination of the specimen from Julian Acuna Gale Herbarium (HIPC), at the university. A preliminary determination placed it within genus Amorphophallus Blume ex Decne (Araceae), which, in spite of being shown in several botanical gardens, and mentioning its presence outside them by the general and social media (Redaction Team, 2009; Fernández, 2020 a, 2020 b), has been poorly recorded in the scientific literature about the Cuban flora. Accordingly, it deserved a more formal research study beyond the service of species identification normally given by the herbarium.

This paper reveals the nomenclature, taxonomic position, and genus description of *Amorphophallus*, and species *A. paeoniifolius* (Dennst.) Nicolson, and *Amorphophallus konjac* K. Koch, whereas the main particularities within family Araceae are discussed, including its potential and corroborated usefulness.

Materials and Methods

This study is part of one of the tasks of an institutional research project (*Contribution to Knowledge and Sustainable Management of Groups Selected for Camagüeyan Biodiversity*), developed by the Center for Environmental Studies of Ignacio Agramonte University of Camagüey. The reflections linked to plant chemistry and usefulness of the taxon also contribute to 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 institutions, funded by the VLIR-OUS program from the Council of Flamingo Universities.

An *in situ* study was done, which consisted in collecting digitalized images, along with a morphological evaluation of plants, in reference to vegetative and reproductive structures, as well as phenological evaluations. Queries were conducted among the inhabitants to check their knowledge about the species observed by the students, possible common names used, and to find out about the initial origin of the propagation material. Representative samples from foliar and reproductive structures were collected, and taken to Julian Acuna Gale Herbarium (HIPC, according to Thiers), at the university. A measure tape and gauge caliper were used for measurements.

The species were identified by comparisons to descriptors, keys, and images published in Hetterscheid & Peng (1995), Jansen, Van der Wilk & Hetterscheid (1996), Heng, et al., (2005); McPherson & Hetterscheid (2011), Madhurima, Kuppast & Mankani (2012), Ramesh & Sudhanshu (2016), Hetterscheid, Medecilo, Callado & Galloway (2020).

Samples from digital herbariums were consulted, particularly from B, BM, K, L, M, MO, NY, and P (according to Thiers, 2020), whose access was given by these sites: JSTOR <http://plants.jstor.org>, EOL <http://eol.org>, and Tropicos <http://www.tropicos.org>. Information was also consulted from these sites: GBIF <https://www.gbif.org>, NCBI <http://www.ncbi.nlm.nih.gov> and BHL <http://www.biodiversitylibrary.org>. The methodology defined by Font Quer (2001) 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, and ULV (according to Thiers, 2020), including the bibliographic review and advisory from specialists associated to these institutions.

Results and discussion

It was confirmed that the plant studied belongs to genus Amorphophallus Blume ex Decne, family Araceae, subfamily Aroideae, tribe Thomsonieae.

Including this, the number of Araceae genuses recorded in the scientific literature about Cuban flora raised to 16 (Gómez de la Maza and Roig, 1916; Arias, 1998; Greuter & Rankin, 2017; González-Sivilla, and Méndez, 2020). The following analytical key was suggested for contrasting them:

1 Aquatic, floating, and free living plants. Subsessile, spongy leaves. Pauciflora spadices ……*Pistia*

1* Ground, saxicola, creeping, epiphytic or hemiepiphytic plants Petiolate, non-spongy leaves. Multiflora spadices ……..... 2

2 Pinnate, compound leaves……. *Zamioculcas*

2* Compound non-pinnate, sometimes pinnatisecta simple leaves, but not completely incised or pedatisecta.....3

3 Basically aerial stems, either erect or creeping, sometimes, at times with a subterranean part that may or not 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 (not adhesive when present)……..... 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 lamina, adult, 20 cm wide or more..... *Alocasia*

6* Yellow and white variegated foliar lamina; ovate, oblong-ovate or narrowly oblong-elliptical to linear, generally less than 20 cm wide..... 7

7 Ovate, oblong-ovate foliar lamina, with over 10 cm wide..... *Dieffenbachia*

7* Narrow oblong-elliptical to linear foliar lamina, less than 10 cm wide…….....*Aglaonema*

8 Stems with whitish longitudinal, prominent, and irregular crests.....*Epipremnum*

8* Smooth stems without whitish longitudinal, prominent, and irregular crests..... 9

9 Fenestrated, pinnatifidus foliar lamina (at least when adult)..... *Monstera*

9* Pedatilobate or entire, non-fenestrated foliar lamina (at least in species observed in Cuba)..... 10

10 Pedatilobulate foliar lamina (at least in adult plants), with reticulate veins between the primary lateral veins..... *Syngonium*

10* Simple, entire, lobate, variably divided or pinnatifidus foliar lamina, but never pedati lobulate, even when adult..... 11

11 Variegated foliar lamina with silver spots .... *Monstera*

11* Evenly green colored foliar lamina ……..... 12

12 Leaves with parallel second-order veins (lateral) .....*Philodendron*

12* Leaves with reticulate second-order veins (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 lamina of up to 40 cm wide or over, evenly green..... *Colocasia*

15 Entire elliptical, foliar lamina attenuated at the base. White spathes when young, which get different green shades when mature..... *Spathiphyllum*

15* Pedatisecta or entire, but never elliptical, foliar lamina, 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 lamina..... *Anthurium*

17* Part of the stem has emerged due to age, generally without many adventitious roots. Membranaceous to slightly coriaceous foliar lamina..... 18

18 Sagittate foliar sheets with the apex tilted toward the ground and ascending basal lobules.....*Xanthosoma*

18* Corded, ascending foliar lamina..... *Alocasia*

19 Plants growing in flooded spaces; ascending leaves..... *Peltandra*

19* Plants growing in non-flooded spaces; elongated petioles; horizontal leaves with apex tilted toward the ground..... 20

20 Ever-entire leaves with evenly colored green foliar lamina..... 21

20* Pedatisecta or entire leaves ..…….. 22

21 Coriaceous foliar lamina..... *Anthurium*

21* Membranaceous foliar lamina.....*Typhonium*

22 Numerous entire leaves around the stem with foliar lamina bearing long whitish spots..... *Xanthosoma*

22* Pedatisecta leaves, generally one per stem, with an even pale green foliar lamina..... *Amorphophallus*

Since no description of *Amorphophallum* Blume ex Decne was found in the literature about Cuban plants, its characterization is presented below:

Amorphophallus Blume ex Decne Nouv. Ann. Mus. Hist. Nat. 3: 366. 1834 (*nom. cons.*). Type *A. campanulatus* Decne. = *A. paeoniifolius* (Dennst.) Nicolson.

Perennial grass, herbaceous, with naked underground tubers. *Tubers* with continuous growth until the inflorescence appears, usually depressed, globose, and large when mature. Large leaves, with continuous growth until inflorescence, solitary on each tuber, seemingly grouped due to emergence in accessory tubers; cylindrical petiole, generally spotted or blemish, from smooth to rough; tripartite limb, each of the three fragments are multifidus; varied number of erect to extended folioles. *Inflorescence*: solitary on each tuber, partially wrapped by a well-developed spathe; cylindrical solid, generally spotted or blemish peduncle, from smooth to rough; funnel-shaped spathe, tubular or bell-shaped, free on one side, and overlapping margins of varied and conspicuous colors, which fades, and often falls following anthesis; spadices with female flowers in the lower part, and male flowers in the upper, with a transition area in the center, and another asexual (no flowers), which is well developed (appendix) in the upper end (after anthesis, the male part of spadix and the appendix generally fall, whereas the female part extends greatly). *Flowers*: Unisex flowers, with no perianth; the female flowers with 1–4 locule ovary, more or less absent or well developed style, entire or lobulate stigma; the male flowers bearing 1–6 stamens; subsessile anthers, deshiscent on an apical pore. *Fruit*: a 1–3 seed berry, subglobose or elongated, generally red or orange when mature (the upper fruits

are first to ripe). *Seeds*: with an embryo proportionally bigger than the endosperm.

This genus is made of some 205 species, some of them with several subspecies. It is widespread in the tropics, from west Africa to Polynesia (Sookchaloem et al., 2016).

The research helped locate references to the presence of three species of this genus in Cuba. The first one was *A. rivieri* Durieu ex Carrière, cited as one of the ornamental plants of the country, by Gómez de la Maza and Roig (1916). The existence of a young specimen of *A. titanum* (Becc.) Becc. ex Arcang, growing in a private collection in Las Tunas province. Finally, the species that made this study possible was identified as *A. paeoniifolius* (Dennst.) Nicolson.

Of the species referred to in the previous paragraph, only *A. rivieri* Durieu ex Carrière and *A. paeoniifolius* (Dennst.) Nicolson have been frequently observed growing in Cuba. *A. titanum* (Becc.) Becc. ex Arcang is limited, according to the information provided, to just one specimen.

The more or less frequently cultivated species in Cuba may be contrasted using the following analytical key:

1 Petiole of up to 200 x 10 cm, green (pale to dark), with lighter spots, generally even (ellipsoid), tiny dark dots, and rough surface. Inflorescence: a 5 cm peduncle; campanulate spathe (inverted).....*A. paeoniifolius*

1* Petiole of up to 100 x 8 cm, whitish, beige, or pink, with generally irregular darker spots, tiny white, pink or beige dots, and verrucose surface, especially at the base. Inflorescence with an up to 110 cm truncate spathe.....*A. konjac*

The data from these species, including the referents of their description, distribution, ethnobotanic, and performance in Cuba, are the following:

1. Amorphophallus paeoniifolius (Dennst.) Nicolson. Taxon 26: 338. 1977 ≡ *Dracontium paeoniifolium* Dennst. Schlussel Hortus Malab.: 13, 21, 38. 1818. Holotype: [icon] Mulen Schena Rheede, Hort. Malab. 11: 37, t 19, 1692 (see Fig. 1).

Perennial, herbaceous, diclino-monoecious plant. *Underground tuber*, generally solitary (at times producing other smaller tubers from lateral buds), globose or sometimes with flattened poles, robust, up to 50 x 30 cm diameter; it can weight up to 15 kg, the color is dark brown, with prominent deep scars. *Compound leaves*, they are generally solitary (two by tuber is rare); erect petioles, like a stem (pseudostem) of up to 200 x 10 cm, fleshy and rough surface, in pale to dark green, having ellipsoid spot patterns, elongated, lighter green in the bottom, with tiny dark dots. *Limb*, pedatisecta, measuring 200-250 x 150-200 cm, divided into three rachis; evenly colored pale green folioles, ovate-oblong, acute 5–14 x 4–10 cm, with numerous strongly printed veins. *Inflorescence*, pedunculate, solitary on each tuber; short peduncle, of approximately 5 cm diameter at the base, cylindrical, solid, pale green, and darker at the base. *Spathe*, campanulate (inverted), rather wide than long, measuring 10–40 cm long and 15–60 cm diameter; the outer surface is pale green to dark brown; extended border, conspicuously undulate, dark brown, garnet colored near the margin, generally with large and small circular paler spots; the inner surface is normally dark garnet-colored, bright at the lowest portion of the base, yellow-greenish at the higher portion, dark garnet-colored at the upper portion to the ridge. *Spadice of up to* 70 cm, fleshy, same size or longer than the spathe; the female area is 5–15 cm long and 2.5-8 cm diameter (including the styles), tightly or remotely distributed flowers; transition area of 1–2 cm; male area strongly obconic, the upper part is roofed against the broad base of the appendix, 2-8 cm long, 3–10 cm diameter at the base (1.5-6.5 cm in the upper part); irregularly globose or elongated appendix, of up to 20 x 20 cm, obtuse in the upper part, irregular, shallow, or deeply folded surface, verrucated, pale or dark violet to brown color. *Female flowers* with depressed or depressed-globose ovaries, 4–5 x 2.5 mm, soft at the base, the rest is brown, 2–3–locular, a basal ovule per locule; very long and thin style, 8–10 x 1.5 mm large capitate stigma, laterally compressed from 4 mm diameter and 3 mm high, 2-3(4) lobulate, conical obtuse lobules, with a white-yellowish color, densely verrucated. *Male flowers* bearing 4-6 stamens; tightly elongated stamens, 5 mm long, 1.5-2 mm diameter, marble white ; extremely short filaments (0.2-0.5 mm), connate; narrowly elongated anthers, 4.5–5 mm long, truncate upper part; elongated apical pores; orange-colored pollen, soft exine. *Fruits* (not observed in Cuba), ellipsoidal to globose berries, compressed in orange-red color, 1.2 cm diameter, shrunk in the septum. *Seeds* (not observed in Cuba), ellipsoidal, almost without endosperm (limited to a few cell layers at the end of hilum); large embryo.

Chromosomal number: 2n= 28 (Anil, Beevy & Siril, 2013).

A. paeoniifolius (Dennst.) Nicolson was initially named by August Wilhelm Dennstedt (1776-1826), as *Dracontium paeoniifolium* Dennst. (Dennstedt, 1818), based on an illustration (Rheede, 1692) made by Dutch army officer Hendrik Adriaan van Rheede tot Drakenstein (1636-1691). Then Dan Henry Nicolson (1933-2016) combined it with *Amorphophallus* (Nicolson, 1977).

This plant, which is favored by the tropical and subtropical climates, is considered native to several territories of south and southeast Asia, the north of Australia and Oceania, including China (part of south China, including Taiwan), Bangladesh, India, Sri Lanka, Laos, Burma, Thailand, Vietnam, Borneo Island, Java Island, Malaysia, the Philippines, Celebes Island, Sumatra, New Guinea, Fiji, and Samoa (Jansen, Van der Wilk & Hetterscheid, 1996; McPherson & Hetterscheid, 2011; Madhurima, Kuppast & Mankani, 2012).

Outside its original spaces, it has been naturalized in Madagascar, whereas in Seychelles, it is known as an invading plant, though no evidence of ecological impact has been found (Senterre, et al., 2020). In the Americas, it has been reported in Nicaragua (Calero, 2016), Honduras, Costa Rica, Puerto Rico, and the peninsula of Florida, in the United States (Tropicos, 2020). Several botanical gardens treasure specimens of the plant, mainly due to the particularities of its inflorescence and phenology (GBIF Secretariat, 2019 b; Tropicos, 2020).

A. paeoniifolius (Dennst.) Nicolson, is not recorded in the West Indies by Acevedo & Strong (2012). The plant is not recorded either in the most relevant catalogs on Cuban flora (De la Sagra, 1845, 1850; Grisebach, 1860, 1864, and 1866; Sauvalle, 1873; Gómez de la Maza, 1889, 1890, 1894a, 1894b and 1897; Gómez de la Maza, and Roig, 1916; Agete, 1939; Seifriz, 1943; Roig, 1965; Robert, 1983; Boldo & Estévez, 1990; Esquivel, Knüpffer & Hammer, 1992; Herrera, 1993; Oviedo, 1994; Arias, 1998; Greuter & Rankin, 2017). Additionally, no herborized specimens were found in HAC, HIPC, and ULV (according to Thiers, 2020).

Specimens observed: Cuba, Camagüey, Julio Sanguily Street, between 2nd and 3rd, Vigia (21°23′36.173″ N – 77°55′8.705″ W), several specimens have been observed at 562, and two adjacent parterres, IX-2019, R. González, HPC-12522, leaf, VI-2020, HPC-12523, reproductive structure (HIPC).

According to the information available, the introduction of this species in Cuba, may be linked to the purchase of specimens for the collections from the Botanical Garden of Cienfuegos (originally Atkins Gardens), since the specimens displayed at the Botanical Garden of Santa Clara were acquired in Cienfuegos (Idelfonso Castañeda Noa, personal communication, June 15, 2020), though this data is not corroborated. So far, there is no solid information about the way in which the first specimen arrived at the Cienfuegos institution.

A. paeoniifolius (Dennst.) Nicolson was observed growing as an ornamental plant, in private and public green areas of several neighborhoods in the municipality of Camagüey: Vigia (the original report for this paper), ELJardin (Dennis Díaz Arzola, personal communication on October 3rd, 2020), Puerto Principe, Jayama, Lenin (Rayner Morales Pérez, personal communication, September 20th, 2020), in an apartment in Previsora, and in the surroundings of Jardines de Tinima Recreational Facility.

Its presence has also been evidenced in private home gardens in the municipality of Minas (Dailyn Abreu Ramiro, personal communication August 20th, 2020). It is also present in several locations of provinces Havana (Fernández, 2020 b), Villa Clara and Cienfuegos (Idelfonso Castañeda Noa, personal communication, June 15th, 2020), Ciego de Ávila (Dennis Díaz Arzola, personal communication, October 3rd, 2020), Las Tunas (Waldo Bonet Mayedo, personal communication, September 22nd, 2020), Holguín (Alejandro Hernández Peña, personal communication, August 18th, 2020), and Granma (Fernández, 2020 a), as well as in scientific collections in the botanical gardens of the same provinces, including Camagüey.

Remarkably, in none of these sites the fruits have been observed, just the inflorescence. Although it is known that the natural mechanisms of pollination are complex, the information available is insufficient to determine the cause of this phenomenon.

Both the specimens growing on Julio Sanguily Street, between 2nd and 3rd Streets, in Vigia, Camagüey city and the ones cultivated at 562, were planted by Julián Rivero Díaz, using a tuber brought from Marta Abreu Central University by his daughter, in 1982 (Julian Rivero Diaz, personal communication, February 12th, 2020). The tuber was given to the then student by a gardener who was in charge of the Botanical Garden of Santa Clara (Isabel Rivero Rodriguez, personal communication, September 13th, 2019).

In the regions where it is considered native, it is known as elephant foot yam, in reference to the shape, and the huge tuber that is harvested for food. Other names given in other parts of the world are 'suranakanda', 'zimikanda', 'ole', 'koniaku', 'konjac', 'konnyaku', 'buk khang', 'kizhangu', 'suvarna gedde', 'oluo', 'kanda gadda' (Singh & Wadhwa, 2014), 'pungapung', 'sweet yam', 'telinga potato', whitespot giant arum', ‘suran’, and 'suweg' (GBIF Secretariat, 2019 b).

In Cuba, no common name has been recorded. Some neighbors in Vigia, Camagüey, refer to it as *flower of the dead* (Lázaro Nápoles Rodríguez, personal communication, August, 24th, 2020), because of the smell of mature flowers.

In other parts of the province, it is called ‘ceiba de jardín’ (*garden ceyba*) (Rayner Morales Pérez, personal communication, September 20th, 2020), due

to the shape the leaf takes (especially the petiole); in Jobabo, Las Tunas, it is given the name 'copa de Santa Bárbara' (*St. Barbara's Cup*) (Waldo Bonet Mayedo, personal communication, September 22nd, 2020), due to the aspect of the spathe; in Holguin, it is known as palma leopardo (*leopard's palm*) (Alejandro Hernández Peña, personal communication, August 18th, 2020), alluding the spots on the petiole. The person who introduced the plant in Vigia, Camagüey said that the people who donated the propagation material named it 'piel de serpiente' (*snake's skin*) or 'cabeza de serpiente' (*snake's head*), due to the coloring and texture of the petiole, and the shape of the leaf when it emerges from the soil, before opening the folioles, which is similar to a snake coming out of the ground (Isabel Rivero Rodríguez, personal communication, September 13th, 2019).

The usefulness of *A paeoniifolius* (Dennst.) Nicolson in the original regions is greater than its ornamental value, as it has been used for human consumption during centuries, mainly in India, the Philippines, Sri Lanka, and other island nations in southeast Asia. The The plant is also known for several nutritional values, with a wide variety of preparations in the traditional cuisines (Nedunchezhiyan, Saurabh & Ranasingh, 2006; Suja, et al., 2017). Also, the existence of an important tradition for this species is the utilization in medicine, motivating studies on the analgesic, anti-inflammatory, antidepressive, antidiarrheal, antioxidant, contraceptive, antihyperglycemic, antimicrobial, anthelmintic, and hepatoprotective effects (Dey & Ghosh, 2010; Purwal, Shrivastava & Jain, 2011; Dey, Ota, Srikanth, Jamal & Wanjari, 2012; Hurkadale, Shelar, Palled, Mandavkar, & Khedkar, 2012; Rahmatullah, Rahman, Swarna, Badal, Hasan & Rahaman, 2014; Singh & Wadhwa, 2014; Van, et al., 2020).

Studies conducted by Majumder, Sharma, Maiti & Mukhopadhyay (2020) revealed encouraging effects on breast cancer cells *in vitro*, reducing apoptosis, and suppressing migration using a treatment based on a preparation named APTE (*Amorphophallus paeoniifolius* Tuber Extract).

The characterization of a group of nitrogen fixing bacteria, particularly *Bacillus cereus* and *Pseudomonas aeruginosa*, which inhabit as symbionts in the roots of *A. paeoniifolius* (Dennst.) Nicolson, evidence the potential of this species, both in natural and introduced ecosystems, as a nutritional enhancer of soil (Anjanadevi, John, John, Jeeva & Misra, 2013).

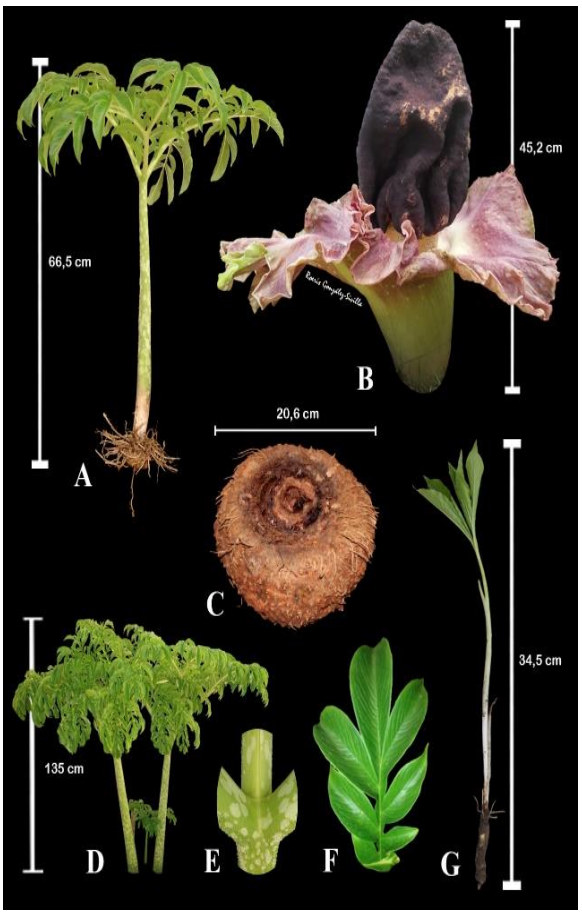

Fig. 1. *Amorphophallus paeoniifolius* (Dennst.) Nicolson, photos and photo composition: Roeris González-Sivilla. The images belong to specimens planted in a parterre on Julio Sanguily Street, between 2nd and 3rd, Vigia, Camagüey. A- Full juvenile specimen. B- inflorescence. C- Tuber D- Foliage in front of residence at 562. B- Inflorescence. E- Detail of petiole segmented in three. F- Detail of the pedatisecta and the veins of one foliole. G- Plantlet growing from tuber segment.

Numerous research studies published reveal the presence and feasibility of phytochemical extraction for various applications, such as ether from oil, chloroform, and methanol, proving the existence of several proportions of carotenoid, flavonoid, alkaloid, phenol, tannin, steroid, protein, fat, and carbohydrate compounds (Das, Sen, Dey, De & Ghosh, 2009; Dey, et al., 2012; Singh & Wadhwa, 2014).

A survey conducted to neighbors on Julio Sanguily Street, and other areas provided no information on the local usefulness of *A. paeoniifolius* (Dennst.) Nicolson, other than the ornamental. There are diverging opinions about the ornamental value of this plant. One of the arguments consists in that between foliar senescence and flowering 3-4 months elapse, during which no plant structure is visible above the ground. Besides, in the first weeks after the flowers that never bore fruit have faded, the only visible object is the pod, which is a cataphyll that precedes the new leaf. Moreover, it is said that the smell of rotten meat given off by the inflorescence when mature, and the inflorescence itself, are disgusting to

the neighbors and the public that walks by the garden, which is strong, attracting flies and other insects. This smell has produced unfounded beliefs about the venomous properties of the plant, which are attributed to the reproductive structure and the vegetative body of the plant.

2. Amorphophallus konjac K. Koch. Wochenschr. Gärtnerei Pflanzenk. 1(4): 262, 1858. Type: not localized[1] (see Fig. 2).

= *Amorphophallus rivieri* Durieu ex Carrière Rev. Hort. (Paris) 42: 573, 1871. Type: not designed.

Perennial, herbaceous, diclino-monoecious plant. *Underground tuber*, generally solitary, brown, slightly bright, globose depressed, up to 30 cm diameter and 20 cm high, it can weight up to 10 kg, producing numerous seasonal long rhizomatous movements with the swollen apical side of up to 50 x 3 cm. *Leaves*, compound, solitary; erect petioles resembling a stem (pseudostem) of up to 100 x 8 cm, fleshy, glabrous or having small pointed dispersed warts at the base, colored whitish-pink or pale whitish beige background, often completely covered with irregular bordering large and big spots, dark green colored, which are confluent, and smaller white dots, or numerous tiny green-blackish dots, very variable. *Limb*, pedatisecta, divided into three rachis, of approximately 200 cm diameter, narrow wing rachis; mate-green folioles, evenly colored, elliptical, acuminate, 3–10 x 2–6 cm, with numerous strongly printed veins. *Inflorescence*, pedunculate, solitary in each tuber, long peduncle (rarely short), colored like the petiole, up to 110 x 5 cm. *Spathe*, truncated, with a pale brownish outer surface, with green-blackish or whitish-grayish spots, with some green-blackish, purple-red dots scattered near the margin; garnate colored inner surface, with or without a paler upper area, elliptic-lanceolate to broadly ovate-triangular, 10–60 x 10–55cm, base and limb ± separated by a shallow constriction, margin ± strongly sinuous, acute apex. *Spadice*, between 15 and 110 cm, which during anthesis of female flowers produces a strong smell of rotten meat, and clear, slightly thick, little sessile drops; cylindrical or narrowly conical female area of 2–11 cm, 1–4 cm diameter at the base, and up to 6 cm diameter in the apex; a transition area with occasional male flowers partially staminoidal and/or pistilloid, or flowers that show all their intermediate stages; slightly fusiform cylindrical or slightly obconic male area, 2–12 x 1–6 cm, with congested flowers. *Flowers*, female, congested or distant; whitish or pale pink ovary, violaceous apex, depressed oval or suborbicular globe in transversal section, 2–2.5 cm high, 2–4 mm diameter, 2 or 3 loculates; violaceous style, 1–5 mm, ± thin, 0.7-1 mm diameter, often clearly ramified in the apex; brownish-yellowish stigma, depressed and strongly undulated, often sunken among the branches of enlarged style, 2 or 3 (or 4) oval or triangular lobules in transversal section, 0.5 mm high, 1.5-2 mm diameter, verruculose-rough. *Flowers*, male, consisting of 3-5 stamens; 2–2.5 mm stamens; yellow-pale orange or whitish filaments, 0.5-1 mm, basal or fully connate, or slightly divergent in the apex; whitish-grayish anthers, or ± beige, truncated or sub truncated, 1–1.5 x 0.8-2 mm, rectangular transversal section; violaceous connective, that turns grayish in anthesis, slightly elevated; apical pores, oval or reniform; narrow fusiform-conical appendix, often laterally compressed, with irregular longitudinal shallow rows, 10–85 x 1.5-6 cm, acute, brown-dark violaceous or paler, densely rough, generally a base with several flattened staminoids resembling a diamond. *Fruits*, globose or spherical compressed berries, yellow-green when mature.

Chromosomal number: 2n= 26 (Liu, et al., 2019).

A. konjac K. Koch is native to south and southeast Asia, especially China, Vietnam, and the Japanese, Philippine, and Indonesian archipelagos (GBIF Secretariat, 2019 a). Outside this region, it is cultivated for ornamental purposes in some European countries, the United States, Mexico, and in Central America (GBIF Secretariat, 2019a).

It not recorded in the West Indies by Acevedo & Strong (2012). Among the most important previously cited catalogs of the Cuban flora, its presence in the country was only mentioned by Gómez de la Maza and Roig (1916), a record confirmed by one specimen in the herbarium collected 36 years later. No evidence of current cultivation in the national territory was found.

Specimens observed: Cuba, Santiago de las Vegas, Jardin Begonia, 5-XII-1952, *J. Acuña* in HAC 18 354 (HAC [photo!]).

In other parts of the world it is commonly named '*lengua del diablo*', '*ñame elefante*', '*lirio vudú*', '*konjac*', '*konnyaku*', '*palma leopardo*', '*palma serpiente*', '*arum sombrilla*', '*titancillo apestoso*', and '*konjac-knölkalla*' (GBIF Secretariat, 2019 a). No common names are recorded in Cuba.

[1] In th the Herbarium of Edinburgh (E), specimen N.W. Yunnan, China, between Za-ping-pu & Jang-pi. Lat.: 25°36´ N, Long.: 99°58´E. IV-1921, George Forrest 20 812 (E #00317887 [photo!]), appears as a neotype of *Amorphophallus konjac* K. Koch, by Wilbert Hetterscheid in 1994. This study could not determine if that designation was effective, and if such was the case, the source that made it so.

Fig. 2. *Amorphophallus konjac* K. Koch, photo by Ramona Oviedo Prieto. Specimen observed in HAC, under the synonym *Amorphophallus rivieri* Durieu ex Carrière.

A konjac K. Koch is used since ancient times by Asian cultures. The first news dates back to 206 B.C., during the Han dynasty in the west of China, where some of its therapeutic properties were studied, and it was used for healing. Some treaties of Oriental medicine, including one attributed to Shénnóng, the mythical Yan Emperor, mentioned this plant (Xu, Xu, Huang, Du, He, & Shen, 2001; Chua, 2011).

Some of the pharmacological values proven by scientific experiments include its properties as hypoglycemic, and it reduces the absorption of carbohydrates in the digestive tract, provides diet fiber, and produces an antioxidant effect (Murti, Panchal, Lambole & Gajera, 2010; Liu, Xu, Zhang, Zhou, Lyu, Zhao & Ding, 2015; Gamboa-Gómez, Guerrero-Romero, Sánchez-Meraz & Simental-Mendía, 2020). Several phytochemicals responsible for hypoglycemic, antioxidant, and immunosuppressive activities have been studied (Liu, Xu, Zhang, Zhou, Lyu, Zhao & Ding, 2015; Dai, Chen, Qi, Ding, Liu, Shao, Han & Wang, 2020), in addition to skin dryness, hyperpigmentation, irritation and redness prevention, through the prescription of glycosylceramide extracts collected from the tuber of *A konjac* K. Koch (Heggar, Puttaswamy & Kodimule, 2020).

It has also been used for human nutrition throughout centuries (Chua, 2011; Singh, Singh & Kumar, 2018). The tuber is consumed in different ways, sliced like noodles, or in jam, sweets, jelly, etc. These preparations have a jelly texture, which is attributed to glucomannan, whose molecule is made of D-mannopyranose and D-glucopyranose, bound at a rate of 1.6:1.0 molar, connected by β-glucoside bonds (1-4) (see Fig. 3). Glucomannan is a hydrophilic non-cellulose polysaccharide with a high viscosity and low caloric content, which is even extracted and sold as an additive, or introduced as gelling agent in jam, jelly, and soft fruit candy. The sales are significant in Asia and Europe, though drastic restrictions have been established in the former due to the high viscosity, which has caused choking accidents (Chua, 2011; Singh, Singh & Kumar, 2018).

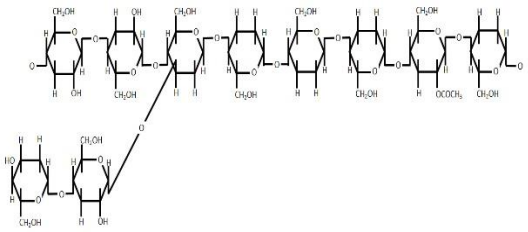

Fig. 3. Chemical structure of glucomannan. Made by the authors based on the diagrams provided by Chua (2011) and Singh, Singh & Kumar (2018).

Apart from glucomannan and glycosylceramide, several other phytochemicals can be found, like trigoneline, saponins, riboflavin, β-carotene, thiamine, coline, niacin, serotonin, betulinic acid, triacontane, lupeol, stigmasterol, β-sitosterol, and palmitate. Most have potential applications in this area given their pharmacological properties (Chintha, Selvakumar, Krishnakumar, Sajad & Sajeev, 2018).

A study presented by Khokar & Menghani (2015) demonstrated that the *A konjac* K. Koch tuber extract, in combination with various organic solvents, such as dichloromethane, ethyl acetate, chloroform, and methanol, have an antibacterial action against microorganisms like *Staphylococcus aureus* Rosenbach 1884, *Klebsiella pneumoniae* (Schroeter 1886) Trevisan 1887, *Escherichia coli* (Escherich, 1885), *Proteus mirabilis* Hauser 1885, *Enterobacter cloacae* Jordan 1890 / Hormaeche 1960, *Enterococcus faecalis* (Orla-Jensen 1919) Schleifer & Kilpper-Bälz 1984 y *Streptococcus pneumoniae* (Klein 1884) Chester 1901.

Conclusions

Amorphophallus Blume ex Decne, denoted at least as *A. paeoniifolius* (Dennst.) Nicolson and *A. konjac* K. Koch given its frequent cultivation as ornamental plant in Cuba, must from now on be included in the specialized catalogs and publications related to the flora of the country. The potentialities for sustainable management of species were identified.

Recommendations

It is necessary to follow up the consolidation, possible expansion, or reintroduction of other specimens or propagulates of *A. titanum* (Becc.) Becc. ex Arcang.

Accordingly, the possibility of exploiting the broad range of economic potentialities of these species should be studied further.

Author contribution

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

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

Conflicts of interest

No conflict of interest has been declared.

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