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Dioon spinulosum (Zamiaceae), a Notable Exotic Tree in Camagüey

Roeris González Sivilla[1] & Julio C. Rifa Téllez[2]

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ABSTRACT

The identity of a tree cultivated in the city of Camagüey for ornamental purposes was revealed. The tree had become popular due to the inexistence of similar specimens in other gardens of the country. The utilization of botanical methods, like collection management, the use of catalogs and keys, and scientific description and illustrations, facilitated its identification as *Dioon spinulosum* Dyer & Eichler. (Zamiaceae), a taxon only recorded in Cuba for scientific collections. The species was described and a key was set up to differentiate the plant to another specimen that belongs to the genus observed on the island, and to determine the possible age of the plant was assessed.

KEY WORDS:/ *Diooeae*, Encephalartiodeae, exotic species, endangered species.

INTRODUCCION

Herbarium Julián Acuña Gale (HIPC) has gathered several requests for identification of an exotic tree from the Zamiaceae family, which grows outside a Camagüeyan building in which various public services have been offered in recent years. Studies to meet such demand demonstrated that the presence of this kind of plant has not been recorded in catalogs or other documents about Cuban gardening. Accordingly, it constitutes an isolated representative, though conspicuously notable due to its overall shape, the size of its leaves, and the huge reproductive organs.

The aim of this paper is to reveal the identity of that specimen, assess the meaning of its presence in the country, estimate age, describe the species, and provide a key for contrasting, which may be useful for further management of the species in Cuba.

MATERIALS AND METHODS

This result was achieved within the framework of the institutional project named *Contribution to Knowledge and Sustainable Management of Groups Selected from Biodiversity in the Province of Camagüey*, developed at the Center for Environmental Management Studies, Ignacio Agramonte

[1]Ph.D. in Pedagogical Sciences, Bachelor of Education, Major in Biology. Associate Professor. Ignacio Agramonte Loynaz University of Camagüey, Cuba: roeris.gonzalez@reduc.edu.cu
[2]Ph.D. in Pedagogical Sciences, Bachelor of Education, Major in Biology. Associate Professor. Ignacio Agramonte Loynaz University of Camagüey, Cuba: julio.rifa@reduc.edu.cu

Loynaz University of Camagüey. It is also part of another project named: *Installing a Center of Excellence in the Central-Eastern Region of Cuba to Enhance Production and Research of Bioactive Plants* (coordinated by the University of Camagüey and the University of Antwerp, funded by the Belgium government through the VLIR-UOS Program.

An *in situ* study included taking digital images and measuring some parts of the plant (trunk, leaves, folioles, and reproductive organs). Instruments like stadiametric reticle (a referent to compare the size of a tree in images), tape measure, and gauge caliper, were used. The shoots and phytomers, leaves per crowns, and stem scars were counted. A representative sample recently included in Julián Acuña Galé herbarium, at the Ignacio Agramonte University of Camagüey (HIPC-Thiers, 2018), was herborized.

The reproductive phenology was determined through monthly observations for 36 months (June 2017-June 2018)

The identity of the specimen was established from comparisons with descriptors, keys, and images from Chamberlain (1909), Vovides, Rees, and Vázquez-Torres (1983), Castañeda (2009) and Gregory, and Haynes & Chemnick (2018). Moreover, a group of digital herbariums from E, MO, K were consulted (Thiers, 2018), whose access was made possible by EOL (<http://eol.org>), Tropicos (<http://www.tropicos.org>), Global Biodiversity Information Facility (<https://www.gbif.org>), and JSTOR (<http://plants.jstor.org>). The Font Quer (2000) terminology was used for description.

The search of possible documentary evidence of the species in Cuba included the review of materials deposited in other herbariums: HAC, HAJB, HIPC, and ULV (Thiers, 2018), along with a review of the literature.

Age estimation of the adult specimen was performed following the recommendations of Chamberlain (1919); the estimate was compared to reports made by Castañeda (2009) for native populations.

RESULTS AND DISCUSSION

The study demonstrated that the specimen belongs to genus *Dioon* Lindl., Zamiaceae family, Encephalartiodeae family. It is made of 14 species native from the Americas, mostly distributed in Mexico, one in Honduras, and probably in Guatemala (Vovides, Rees and Vázquez-Torres, 1983). This species is mainly cultivated in private gardens and is part of botanical collections, particularly in Mexico, The United States, The United Kingdom, Sweden, South Africa, Australia (Discover Life, 2018), Spain (Botanical Garden of Malaga University, 2018), and Belgium (Botanical Garden Meisel, 2018). In Cuba, excluding academic collections, it had only been reported as *D. edule* Lindl. in Havana (González, 2003; Greuter and Rankin, 2017).

The species was identified as, *Dioon spinulosum* Dyer & Eichler., a previously scientifically described taxon in 1883 (Eichler, 1883). The data related to name, description, distribution, ethnobotany, and behavior in Cuba are shown below:

Dioon spinulosum Dyer & Eichler. Gart.-Zeitung (Berlin) 2(Sig. 29): 411. 1883. Holotype: [specimen] México, Yucatán, Progreso, 1880, *C.J. Hoge n.a.* (K [photo!]). (Fig. 1).

Dioic plants resembling palm trees. Aerial rarely branched cylindrical and robust trunk, 3-16 m high. The crust is covered with persistent ring-like scars from petioles. Leaves: persistent,

pinnate-compound, dark green, bright, glabrous, slightly curved, arranged in apical crowns (20-30 pinnae per crown); pale green when young, hairy in the petiole and rachis; sub-triangular-flattened *petioles* at the base (9 cm long max.). Inermes: sub-cylindrical rachis, inermes with persistent base on the stem after the fall of lamina, 150-200x30-40 cm limbs. Folioles of approx. 100 pairs, distributed almost from the base of the petioles in adult leaves, sub-opposite, seated, slightly superimposed, long-lanceolate or squamiform-cuneiform near the petioles, of up to 15-20x1.5-2 cm toward the mid portion of the leaf, denticulate or spinulose margin, with 3-10 spinulae on the upper side and 2-6 in the interior; 10-28 veins, ending in an apical thorn. Male strobili (not observed in Cuba): erect, elongated, 40-55 cm long and 7-10 cm of diameter; triangular microsporophylls, laminal (3-4x2 cm). Globose female strobili, erect at young age, hanging when mature, 35-59 cm long and 22-30 cm of diameter. They can weigh up to 25-30 kg; peltate hairy, spiraled, and superimposed megasporophylls, 7-8x7-8 cm. Seeds: (not observed in Cuba) ovoid, multi-angulated, and planar between the angles, 4-5.2 cm long and 3-3.5 cm of diameter, bright yellow, and fleshy outer tegument. The ♂ strobili emerge between May and July, and disintegrate shortly after; the ♀ ones emerge between June and July, but remain in the plant for 17 months.

Fig. 1. *Dioon spinulosum* Dyer ex Eichler, in the interior garden of the Camagüey headquarters of the Communist Party of Cuba. Details of trunk, leaves, folioles, and female strobilus.

Originally from Mexico, from Oaxaca to Veracruz (Castañeda, 2009). It is cultivated in other regions of Mexico and the United States. It is frequently seen in botanical gardens worldwide.

Chromosomal number 2n = 18 (Vovides, Rees and Vázquez-Torres, 1983; Castañeda, 2009).

Specimen observed: Camagüey, one of the interior gardens of the building that hosts the Central Committee of the Communist Party of Cuba in the province (location: 21°22´08.8 N – 77°54´08.4 W), *R. González*, HPC-12048, 8-II-2018 (HIPC).

This species is generally cultivated for ornamental purposes; therefore, this specimen has been irrationally removed from its natural habitat. The individual identified in Camagüey serves ornamental purposes.

Although not widely used, the plant also has nutritional qualities; the Tuxtepec originals use the plant to make tamales and *memelas* from the ground seeds (Chamberlain, 1909; Vovides, Rees and Vázquez-Torres, 1983). In some communities of Oaxaca and Veracruz, the foliage is used to decorate churches during special celebrations, and the seed testas are used to make necklaces and toys for children (Vovides, Rees and Vázquez-Torres, 1983).

Researchers say that the methylazoximethanol extracted from *Dioon spinulosum* produces a decrease of gross motor function and an increase in the excitability of the central nervous system, causing symptoms of epilepsy in rats (Contreras, Saavedra, Martínez, Ortiz, & Vázquez-Torres, 1998). In turn, Carabias (2000), mentioned cicasin and macrozamin, present in Zamiaceae, as highly cancerous compounds. Other studies demonstrated the presence of cicasin, macrozamin, β-methylamino-L-alanine, and methylazoximethanol, whose neurotoxic effects were corroborated in mice (Rivadeneyra Domínguez, Saavedra, and Rodríguez Landa, 2009).

The Red List of IUCN included this species as Rare (R) in 1998; in 2003, it moved to Vulnerable (VU). Since 2010, it is in the Endangered (EN) category. The main arguments indicate that a 50%-90% decline has been observed in their natural habitats of different subpopulations, with an average estimate 70% decline in the last two generations (Vovides, Chemnick & Gregory, 2010).

Common names in Cuba: *palma grande* (personal communication of the gardeners that care for the specimen reported).

Dioon spinulosum Dyer & Eichler. is not recorded in the most relevant catalogs of flora in Cuba (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; González, 2003; Acevedo & Strong, 2012; and Greuter & Rankin, 2017). Likewise, no herborized specimens were found in HAC, HIPC and ULV (Thiers, 2018).

The plant is cultivated in the National Botanical Garden of the University of Havana, and it is reported in HAJB (Thiers, 2018), herbarium from that institution (National Botanical Garden, 1993-94, 2018). Furthermore, it is part of the Central Bank of germplasms, at the Institute of Fundamental Research in Tropical Agriculture (Fundora, *et al*., 2004). Accordingly, it is recorded in the National Network of Information on Biodiversity of Cuba (Institute of Ecology and Systematics, 2018). The specimen cultivated in Camagüey is the first record of the species in the country, other than scientific collections guarded by specialized institutions. However, the possibility of cultivation in other locations, not yet identified, should not be disregarded.

To contrast this genus from the others of Zamiaceae family in Cuba, the key devised by González (2003) can be used. The two species of the same genus known so far can be identified with the use of the analytical key below:

1 Folioles of the mid portion of mature leaves, up to 1.2 cm wide in adult individuals, with denticulate margins in young plants, and whole in adult plants; 9-12 veins, ending in a thornless tip. 25-30 cm long female strobili, with a diameter of 15 cm. Adult arborescent plant, ≤ 5 m high.....*D. edule.*

1* Folioles of the mid portion of mature leaves, up to 1.5-2 cm wide in adult individuals, with denticulate or spinulose margins, 3-10 spinulae in the upper side and 2-6 in the interior; 10-28 veins, ending in an apparent thorny tip. 35-59 cm long female strobili, with 22-30 cm of diameter. Adult arborescent plant, > 5 m to 15-16 m high.....*D. spinulosum.*

Only one adult specimen was detected, female, approximately 4.75 m high, in seemingly good physical condition, normally producing strobili (one of the strobili observed was 50 cm long and 29.5 cm diameter), persistent for about 18 months in the plant. In this case, each crown is made of 23-27 leaves of up to 1.91 m long, with 103 pairs of 25.1x2 cm long folioles, on average. The trunk reaches 42.2 cm wide in the mid portion (the base could not be measured accurately due to the presence of shoots). At the time of the study, the main plant was accompanied by eight healthy shoots of little more than two years of age, which were connected to the trunk and derived from the base. Additionally, there were various phytomers above 1 m high. The plant grows in the building that houses the Camagüey headquarters of the Communist Party of Cuba.

The presence of this exotic tree in Cuban gardens is highly exceptional. However, there is no precise information in relation to the way this plant was introduced in the country and when it was planted in the place. Few and scatter testimonies were collected from people who somehow were related to the plant during the last 70 years. The current headquarters of the Central Committee of the Communist Party of Cuba in Camagüey used to be the Provincial Office of the Ministry of the Sugar Industry, and before that, it was the seat of the Ministry of Agriculture in Camagüey. Former officials of these institutions claimed that by 1981, that specimen was already there, up to 3 m high (Luisa Máxima Pérez Arencibia, personal communication).

Therefore, it is evident that this tree had been planted before the 1970s, when the building became public. In the whole compound, the building that resembles a home most must have been built in the mid Twentieth Century, according to the modern construction style of that time in the country (Gómez, Cento, Prieto *et al.*, 2009). In addition to that, only the identity of the last private owner was known. He was a cattle land owner named Juan Porro, who became relevant for his collection of fighting cocks, which he used to sell under the brands *pati-verdes* (green legs) (Fidel García Basulto, personal communication). However, whether this family planted the tree or not, or whether it was planted by another hypothetical family or unknown former proprietors, is still unclear.

The little information presented above is coherent with the estimations made, which indicate that this plant species may be over 100 years old. These estimations were based on the methodology suggested by Chamberlain (1919), who linked average annual leaf production per plant to the number of scars left by the petioles still on the trunk. Since this is the only adult specimen (the shoots are not well developed), the proposal of Vovides and Peters (1987), later corroborated by

Castañeda (2009) for native populations, could not be backed, as they linked height to the number of scars and leaf average.

The good preservation state of the trunk facilitated a very accurate count of petiole scars, which totaled 2 530. The average of pinnae per crown was 25. Hence, considering that foliar production takes place every two years, the tree was estimated to produce an approximate of 12.5 leaves. Based on previous figures, the age of this specimen could be estimated as over 200 years, which is not rare. Ages of 201 years have been reported in Mexico for 2-3 m high individuals, and more than 460 years for 3.1-6 m high individuals (Castañeda, 2009).

However, following this linear interpretation of results is not advisable, due to the inaccuracy of the method suggested, and because the conditions of the plant in Cuba are quite different from the ones on their original location. Therefore, the age estimated may not correspond to the probable date of construction of the buildings.

Hence, either this particular specimen was planted before construction, or it was moved there as an adult. The latter scenario seems to be the most likely cause. For centuries, the common practice of ornamental plant dealers consisted in removing young-adult individuals from their natural habitats, instead of using seeds for propagation. The previous has been considered by specialists as one of the main grounds for the decline of this and other populations of *Dioon* Lindl. species. (Pérez and Vovides, 1997; Carabias 2000; Mayett, Castañeda, and Barajas, 2014).

The existence of only one female individual in Camagüey is a serious limitation to start preservation actions, but opens the door to artificial fertilization trials using pollen from other regions of the world, in order to diversify the existing germplasm in Cuba.

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