Seijo, J. G., M. A. Burgos, A. V. García & A. Krapovickas†. 2025. *Arachis woodii* (Leguminosae): a new species from the bolivian Pantanal. Bonplandia 34(1): 1-7.
Doi: https://doi.org/10.30972/bon.3417880. Recibido 30 Mayo 2024. Aceptado 15 Julio 2024.
Publicado en línea: 30 Octubre 2024. Publicado impreso: 15 Febrero 2025.
ISSN 0524-0476 impreso. ISSN 1853-8460 en línea.

Arachis woodii (Leguminosae): a new species from the bolivian Pantanal

Arachis woodii (Leguminosae): una nueva especie del Pantanal boliviano

José G. Seijo[1,2*], Margoth Atahuachi B. Margoth Atahuachi B. [3], Alejandra V. García[1] & Antonio Krapovickas[1†]

Summary: Based on the analysis of materials collected in botanical expeditions conducted since 2000 in underexplored regions of Bolivia, in this study we present a novel species to science: *Arachis woodii*. This species has been collected a few times from a single location in the western edge of the Pantanal swamps, where it thrives in black shallow soil over rock outcrops. While the morphology of its vegetative organs resembles, to some extent, that of *A. glandulifera* and species of the K genome, a set of features differentiates it. *Arachis woodii* exhibits large, somewhat dorsiventrally flattened fruits with a prominent somewhat recurved beak, akin to classical elf shoes. The exocarp is dark brown and deeply reticulated. Additionally, the bristles on the lower surface of the leaflets lack a disc of glandular tissue at the base, a trait clearly distinguishing it from *A. glandulifera*. Chromosomal and molecular marker analyses indicate that this species does not align with any of the genome types described so far in section *Arachis*.

Key words: Germplasm, Pantanal, peanut.

Resumen: Continuando con el análisis de los materiales coleccionados en expediciones botánicas realizadas en regiones poco exploradas de Bolivia desde el año 2000, presentamos una nueva especie para la ciencia: *Arachis woodii*. Esta especie fue coleccionada múltiples veces de una sola localidad en el borde occidental del Pantanal, prosperando en suelos negros poco profundos sobre afloramientos rocosos. Aunque la morfología de sus órganos vegetativos se asemeja, en cierta medida, a la de *A. glandulifera* y a la de especies del genoma K, un conjunto de características permite distinguirla. *Arachis woodii* presenta frutos grandes, algo aplanados dorsiventralmente, con un pico prominente, similar a los zapatos clásicos de los elfos. El exocarpo es marrón oscuro, profundamente reticulado. Además, la superficie inferior de los folíolos tiene cerdas sin un disco de tejido glandular en la base, un rasgo que la distingue claramente de *A. glandulifera.* Los análisis cromosómicos y de marcadores moleculares indican que esta especie no pertenecería a ninguno de los tipos genómicos descriptos hasta el momento para la sección *Arachis*.

Palabras clave: Germoplasma, maní silvestre, Pantanal.

Introduction

Section *Arachis* is the largest and most diverse of the homonymous genus (Krapovickas & Gregory, 1994; Valls & Simpson, 2005; Seijo *et al*., 2021). Its 32 species are arranged into six different genomes (A, B, D, F, G, and K), with two different basic chromosome numbers (x= 9, 10) and two ploidy levels (2x and 4x) (Smartt *et al*., 1978; Gregory &

[1] Instituto de Botánica del Nordeste (IBONE, UNNE-CONICET), Facultad de Ciencias Agrarias, Campus Sargento Cabral, Corrientes, Argentina. E-mail: jgseijo@yahoo.com
[2] Facultad de Ciencias Exactas y Naturales y Agrimensura, Universidad Nacional del Nordeste, Campus Deodoro Roca, Corrientes, Argentina.
[3] Herbario Forestal Nacional Martín Cárdenas (BOLV), Centro de Biodiversidad y Genética, Universidad Mayor de San Simón, Cochabamba, Bolivia.

Gregory, 1979; Stalker, 1991; Fernández & Krapovickas, 1994; Seijo *et al*., 2004, 2007; Robledo & Seijo, 2008, 2010; Robledo *et al*., 2009; Silvestri *et al*., 2015).

Among the species with 20 chromosomes, the A and B genomes are the most diverse, comprising 15 and 6 species, respectively. The A genome has a wide distribution south of the Amazon region, extending to the Río de la Plata, while the B genome is concentrated in the Chiquitano Plateau, with two species out of this area. The other genomes (D, F, and K) consist of fewer than three species each, with the D genome being the least diverse, comprising only one species, *A. glandulifera* Stalker. The K genome is mainly restricted to the Chaco region in its northwest portion, the F genome to open plains with *Copernicia alba* Morong in the Beni River basin, near the city of Trinidad (and also in Guayaramerín, Bolivia), and the D genome to the Chiquitano Plateau and neighboring regions in Brazil (Krapovickas & Gregory, 1994, Custodio *et al*., 2013).

The Pantanal is one of the regions that remains poorly explored in Bolivia, particularly its central and southwestern parts. This region is characterized by a significant portion of its surface being temporarily or permanently flooded. However, it also has elevations and some mountain ranges with cerrado vegetation or deciduous Chiquitano forest and grasslands (the latter known as pampas), which could potentially harbor novelties for the genus. Notably, this same region on the Brazilian side, where more exploration has been carried out, has a large diversity of *Arachis* species (Jarvis *et al*., 2003).

The analysis of *Arachis* samples collected by Margoth Atahuachi and colleagues in 2007, and John R. I. Wood and colleagues in 2008 in this area, allowed us to identify the specimens *Atahuachi et al. 1469* (CTES) and *Wood et al. 24579* (USZ), whose morphology could not be assimilated to any known species. For this reason, in a collaboration established by researchers from the Instituto de Botánica del Nordeste in Corrientes (Argentina) with those from the Herbario Nacional de Bolivia in La Paz (LPB), Herbario Nacional Forestal Martín Cardenas (BOLV) in Cochabamba, and the Herbarium of the Museo de Historia Natural Noel Kempff-Mercado in Santa Cruz de la Sierra (UCZ), all from Bolivia, new expeditions were conducted to the area where this population lives, during 2010 and 2012. Herbarium acronyms follow Thiers (2021).

Throughout these expeditions, only one population was located in the area. It was studied in the field, and sufficient new material was collected for biosystematic studies. The type locality is on the western edge of the Pantanal and the population consist of hundreds of individuals growing in shallow black clayey soils on rocky outcrops. The plants displayed an erect main stem with a few lateral branches. They also have vertical pegs, which undoubtedly place these specimens within section *Arachis*. The morphology of the vegetative organs of the specimens observed in the field and in the herbarium showed some resemblance to *A. glandulifera* and to species of the K genome. However, they mainly differ from K genome species by having a large, somewhat dorsiventrally flattened fruit with a prominent beak and a dark brown exocarp with deep reticulation, resembling the shape of an elf shoe. The fruit also differs from that of *A. glandulifera*, which is smaller, not too elongated and has light brown exocarp and lower reticulum. Furthermore, the bristles present in the leaflet´s bottom lack glands (or have very small ones) at the base, a character that clearly distinguishes it from that in *A. glandulifera,* which has bristles with a big glandular disc at their base. These large glands in dry material appear as dark depressions in the hypophyll and as dark dots in the epiphyll of leaflets in the latter species (Figs. 1 and 2).

Here we present the formal description of this new species with fruits similar to elf shoes. The taxonomic and morphological information is discussed with chromosome and genetic data from other works.

Arachis woodii Seijo, Atahuachi & Krapov. sp. nov. Figs. 1; 2A, C, E. *Typus*: BOLIVIA, Santa Cruz, Germán Busch, camino de El Carmen a Rincón del Tigre, 18º23’52”S, 58º20’W, 460 m, 5-XII-2007, *M. Atahuachi et al. 1469*, con E. Amurrio, T. Ramos, D. Soto & L. Ramos (*holotypus* BOLV, *isotypus*

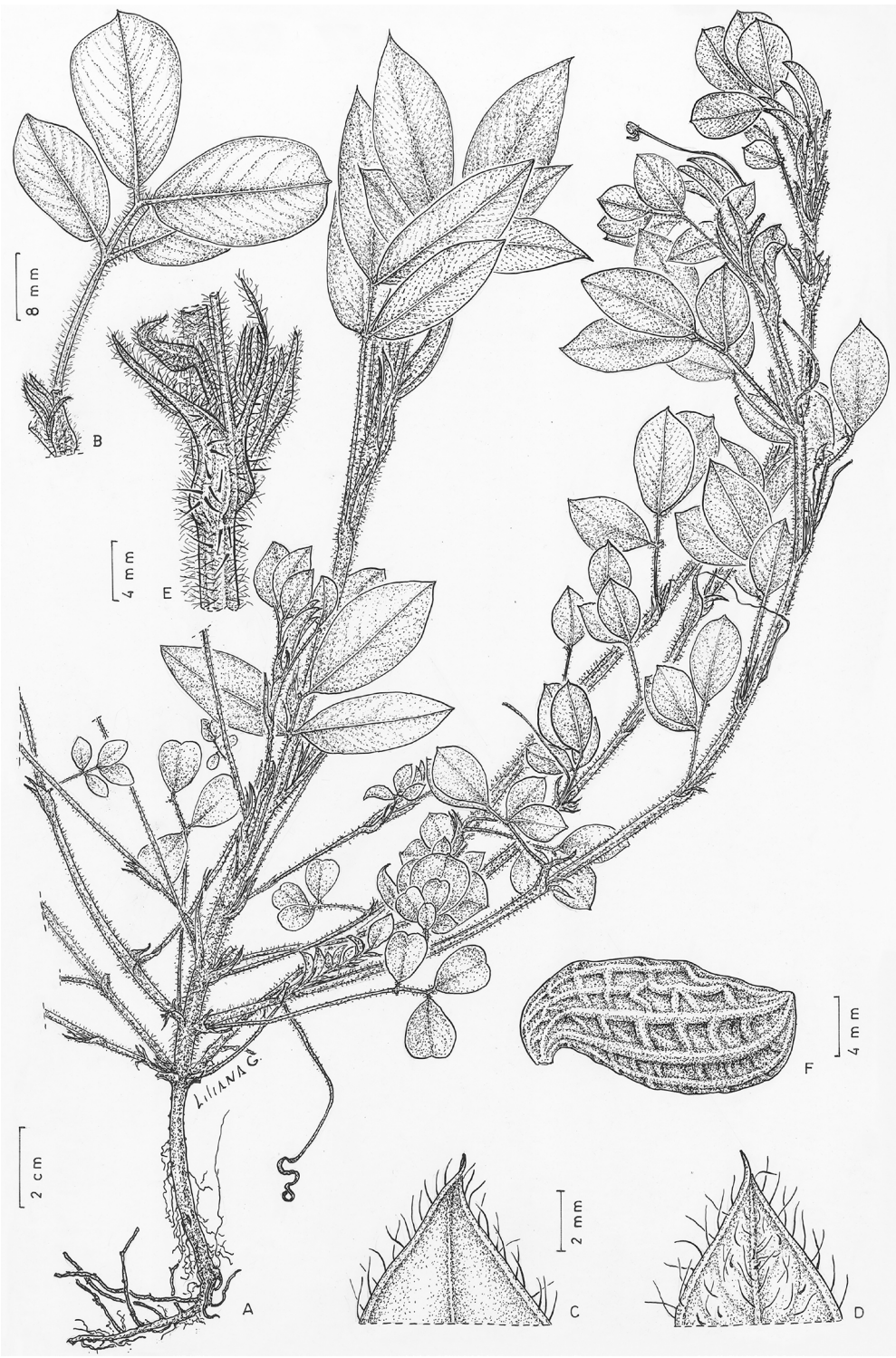

Fig. 1. *Arachis woodii*. A: Main axis and lateral branches of a young plant. Note a vertical peg close to the main axis. B: Leaf with stipules. C: Details of the upper surface of a leaflet apex. D: Details of the lower surface of a leaflet apex. E: Details of the stipules and stem. F: External view of the fruit, with a pronounced beak and the exocarp with deep reticulum. A-F: *Atahuachi et al. 1469* (CTES), drawing by Liliana Gómez.

CTES).

Morphologically similar to Arachis glandulifera Stalker, but differing by the bristles lacking a basal glandular disc in the lower surface of the leaflets; fruits larger, dorsiventrally flattened, with a prominent beak, the exocarp dark brown and deeply reticulated.

Annual herb, mainstem erect 30-50 cm long, somewhat quadrangular in dry specimens. Lateral branches, usually few, up to 40-60 cm long, the basal ones prostrate, the others decumbent. Stems green, covered with yellowish bristles 2-2.5 mm long and white undulated 2 mm long hairs. Leaf tetrafoliolate. On main stem, stipules 8-10 mm long in the fused portion and 13-18 mm long in the free portion, 1 mm wide; petiole 30-45 mm long and rachis 4-10 mm long. Leaflets lanceolate, acuminate, the distal ones 35-50 × 13-20 mm and the basal ones 27-45 × 11-20 mm. On lateral branches, stipules with the fused portion 5 mm long, the free portion 10 × 1 mm. The distal leaflets 15-25 × 10-15 mm and the basal ones 15-22 × 8-10 mm. Stipules densely covered by two strata

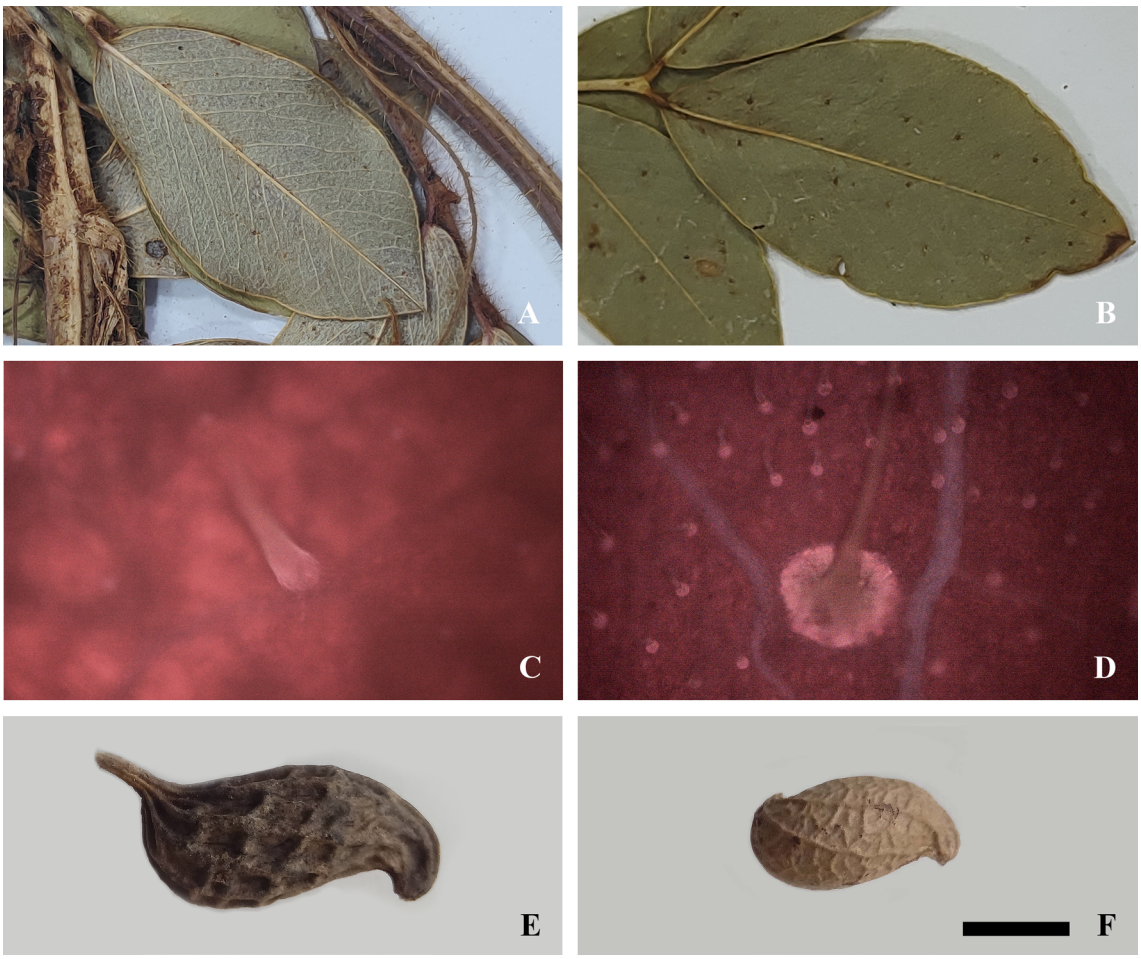

Fig. 2. Morphological characters that distinguish *Arachis woodii* (A, C and E) from *A. glandulifera* (B, D and F). A-B: Lower surface of the leaflets in both species. C- D: Close up of the bristles in both species; note the large disc-like glands at the base of the bristles in *A. glandulifera,* absent in *A. woodii*. The microstructures on the lower surface of the leaflet were analyzed, leveraging their autofluorescence, with a confocal microscope. E-F: Fruit segments; note differences in color, reticulation andshape of the segments. Scale bar = 1 cm in A, B, E and F, and = 0.25 mm in C and D.

of hairs, one short, appressed, and another with 2 mm long hairs, and bristles on the outer surface. Petiole and rachis pilose with 2 mm long hyaline hairs and many bristles. The upper surface of the leaflets glabrous, without dark brown or black marks; the lower surface with 0.2 mm appressed hairs, sparse erect 2 mm long hairs and abundant short bristles 0.5-1 mm long, without a disc of glandular tissue at their base, spread over the whole surface; midvein and margin with long hairs and some bristles. Hypanthium 40-50 mm long, covered with hairs 1-2 mm long. Calyx bilabiate with the upper lobe 3 mm long and the lower lobe narrow, 6 mm long, with long hairs and bristles. Standard petal orange and the wings yellow. Pegs vertical, aerial part with abundant 1 mm long hairs and bristles. Fruits segments large, dorsi-ventrally flattened, 15-20 × 0.8-10 mm, with a prominent beak and strongly reticulated exocarp, dark brown.

Etymology: We dedicate this species to John R. I. Wood, presently a Senior Research Associate in the Department of Biology at the University of Oxford, who has made significant contributions to the knowledge of the Bolivian Flora and collected a paratype of the species.

Chromosome number: 2n=2*x*=20, symmetric karyotype in the accession *Atahuachi & al. 1860* (García, A. & G. Seijo, unpublished).

Geographic distribution and habitat: This species is only known from the type locality. It grows in the eastern extreme of the Santa Cruz department, in open patches of deciduous low forest (Fig. 3A). The area of 100 × 50 m was densely covered by specimens of this species (Fig. 3B).

Paratypi. **BOLIVIA**, **Santa Cruz**. Prov. Germán Bush, 28 km al sur de El portón de la misión del Rincón del Tigre, 18º23'52"S, 58º20'01"W, alt. 458 m, 28-IV-2008, *Wood et al. 24579* (USZ); id., 10-VII-2012, *Atahuachi et al. 1860* (BOLV, CTES).

Obs 1: *Arachis woodii* belongs to section *Arachis* and it is more similar to *A. glandulifera* (D genome) than to any other species of the genus; but also, some characters resemble the species of the K genome (*A. batizocoi* Krapov. & W. C. Greg., *A. cruziana* Krapov., W. C. Greg. & C. E. Simpson, and *A. krapovickasii* C. E. Simpson, D. E. Williams, Valls & I. G. Vargas). However, *A. woodii* can be distinguished from these species by a set of characters (Fig. 2) that are depicted in the following key.

1. Fruits with smooth pericarp (K Genome). 2
1'. Fruits with reticulated pericarp. 4
2. Pegs without bristles. ..... *A. batizocoi*
2'. Pegs with bristles. 3
3. Lanceolate leaflets, lower surface with bristles. ... . *A. cruziana*
3'. Ovate to elliptical leaflets, lower surface without bristles. ..... *A. krapovickasii*
4. Lower surface of the leaflet with bristles with conspicuous glandular disc at their base. In dry material, the glandular tissue seen as dark brown depressions in the hypophyll. Usually, also evident in the epiphyll as dark dots. Asymmetric karyotype. ..... *A. glandulifera*
4'. Lower surface of the leaflet with bristles without (or with very small) glandular tissue at their base. In dry material, never seen dark brown depressions at the base of the bristles. Dark dots never evident in the epiphyll. Symmetric karyotype. ..... *A. woodii*

Obs. 2: Genotyping data based on SNPs markers place *Arachis woodii* outside the clusters formed by the species of the K and D genomes (Leal-Bertioli *et al*., 2024), suggesting that it does not correspond to any of these genomes. *Arachis woodii* stands alone on a branch outside of the two main clusters of the phylogenetic tree of *Arachis* section, with the G genome species, *A. vallsii* Krapov. & W. C Greg, and *A. hoehnei* Krapov. & W. C. Greg. each on independent branches at the base of the tree.

Obs. 3: *Arachis woodii* lives on shallow, clayey hard black soil in patches of rock outcrops (Fig. 3). This soil type is very

Fig. 3. Environment where *Arachis woodii* lives. A: Panoramic view of the habitat of the population in open patches of deciduous forest. B: Detail of the dense population inhabiting shallow black soil on rock outcrops.

different from the sandy places or even the dunes of pure white, yellow or red sand where the species of the K genome and most populations of *A. glandulifera* live. However, the soil type of *A. woodii* is more similar to that of some populations of *A. glandulifera* (*Seijo et al. 3000*, *3222*, and *3622*) from South Concepción, in Ñuflo de Chavez province, Santa Cruz department, which lives in pockets of shallow sandy-clayey soil on rock outcrops.

Acknowledgements

We acknowledge to the Myndel Botanica Foundation for providing funding to support the expeditions in Bolivia in 2010 (to GS) and in 2012 (to MA) and to Agencia Nacional de Promoción Científica y Tecnológica, Argentina, for contributing with funds to these expeditions and for the characterization of the materials collected (Projects PICT-2012-1875 and PICT-2018-03664 to GS). We also extend our gratitude to the Global UNEP/GEF Project 'Conservación *in situ* de parientes silvestres de cultivos a través del manejo de información y su aplicación en campo' - Componente Bolivia (Fundación Simón Patiño-CIFP. Period: April 2005 – April 2010). We also acknowledge to all the collectors that participated in the expeditions for their help in the fieldwork. We especially thank to Stephan Beck of LPB, who made possible the initial collaborations between Argentinian and Bolivian institutions. The drawing of *A. woodii* is greatly acknowledged to Liliana Gómez, retired Scientific Illustrator at IBONE. We extend our gratitude to José F. M. Valls and an anonymous reviewer for their valuable observations that helped to improve this manuscript.

Bibliography

Custodio, A. R., Seijo, G. & Valls, J. F. M. (2013). Characterization of Brazilian accessions of wild *Arachis* species of section *Arachis* (Fabaceae) using heterochromatin detection and fluorescence in situ hybridization (FISH). Genetics and Molecular Biology 36: 364-370. http://dx.doi.org/10.1590/S1415-47572013000300011

Fernández, A. & Krapovickas, A. (1994). Cromosomas y evolución en *Arachis* (Leguminosae). Bonplandia 8: 187-220. https://doi.org/10.30972/bon.81-41499

Gregory, M. P. & Gregory, W. C. (1979). Exotic germplasm of *Arachis* L. interspecifc hybrids. Journal of Heredity 70: 185-193. https://doi.org/10.1093/oxfordjournals.jhered.a109231

Jarvis, A., Ferguson, M. E., Williams, D. E., Guarino, L., Jones, P. G., Stalker, H. T., Valls, J. F. M., Pittman, R. N., Simpson, C. E. & Bramel, P. (2003). Biogeography of wild *Arachis*: assessing conservation status and setting future priorities. Crop Science 43: 1100-1108. https://doi.org/10.2135/cropsci2003.1100

Krapovickas, A. & Gregory, W. C. (1994). Taxonomía del género *Arachis* (Leguminosae). Bonplandia 8:

1-186. https://doi.org/10.30972/bon.160158

Leal-Bertioli, S. C. M., De Blas, F. J., Chavarro, M. C., Simpson, C. E., Valls, J. F. M., Tallury, S. P., Moretzsohn, M. C., Custodio, A. R., Stalker, H. T., Seijo, J. G. & Bertioli, D. J. (2024). Relationships of the wild peanut species, section *Arachis:* A resource for botanical classification, crop improvement and germplasm management. American Journal of Botany 111: e16357. https://doi.org/10.1002/ajb2.16357. 21 p.

Robledo, G. & Seijo, J. G. (2008). Characterization of *Arachis* D genome by FISH chromosome markers and total genome DNA hybridization. Genetic and Molecular Biology 31: 717-724. https://doi.org/10.1590/S1415-47572008000400019

Robledo, G. & Seijo, J. G. (2010). Species relationships among the wild non-A genome of *Arachis* species (section Arachis) based on FISH mapping of rDNA loci and heterochromatin detection: A new proposal for genome arrangement. Theoretical and Applied Genetics 121: 1033-1046. https://doi.org/10.1007/s00122-010-1369-7

Robledo, G., Lavia, G. I. & Seijo, J. G. (2009). Species relations among wild *Arachis* species with the A genome as revealed by FISH mapping of rDNA loci and heterochromatin detection. Theoretical and Applied Genetics 118: 1295-1307. https://doi.org/10.1007/s00122-009-0981-x

Seijo, J. G., Lavia, G. I., Fernández, A., Krapovickas, A., Ducasse, D. & Moscone, E. A. (2004). Physical mapping of 5S and 18S-25S rRNA genes evidences that *Arachis duranensis* and *A. ipaënsis* are the wild diploid species involved in the origin of *A. hypogaea* (Leguminosae). American Journal of Botany 91: 1294-1303. https://doi.org/10.3732/ajb.91.9.1294

Seijo, J. G., Lavia, G. I., Fernández, A., Krapovickas, A., Ducasse, D., Bertioli, D. J. & Moscone, E. A. (2007). Genomic relationships between the cultivated peanut (*Arachis hypogaea* - Leguminosae) and its close relatives revealed by double GISH. American Journal of Botany 94: 1963-1971. https://doi.org/10.3732/ajb.94.12.1963

Seijo, G. J., Atahuachi, M., Simpson, C. E. & Krapovickas, A. (2021). *Arachis inflata*: A New B Genome species of *Arachis* (Fabaceae). Bonplandia, 30: 169-174. http://dx.doi.org/10.30972/bon.3024942

Silvestri, M. C., Ortiz, A. M. & Lavia, G. I. (2015). rDNA loci and heterochromatin positions support a distinct genome type for x = 9 species of section *Arachis* (*Arachis*, Leguminosae). Plant Systematic and Evolution 301: 555-562. https://doi.org/10.1007/s00606-014-1092-y

Smartt, J., Gregory, W. C. & Gregory, M. P. (1978). The genomes of *Arachis hypogaea*. Cytogenetic studies of putative genome donors. Euphytica 27: 665-675. https://doi.org/10.3146/i0095-3679-28-2-12

Stalker, H. T. (1991). A new species in section *Arachis* of peanuts with a D genome. American Journal of Botany 78: 630-637. https://doi.org/10.1002/j.1537-2197.1991.tb12587.x

Thiers, B. (2017). Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden´s Virtual Herbarium. Accessed 15/03/2024. Index http://sweetgum.nybg. org/ih/

Valls, J. F. M. & Simpson, C. E. (2005). New species of *Arachis* (Leguminosae) from Brazil, Paraguay and Bolivia. Bonplandia 14: 35-64. https://doi.org/10.30972/bon.141-21387