Real Identity of *Witheringia sellowiana* (Solanaceae), Typification, and Chromosome Number

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Communicating Editor: Kenneth M. Cameron

Abstract—The identity of Witheringia sellowiana, a narrow endemic species from São Paulo (Brazil), is reconsidered. After analysis of the protologue and the morphological characters of the type material and recent flowering collections, a new combination is proposed (Aureliana sellowiana (Sendtn.) Barboza & Stehmann). A lectotype and epitype are designated here. A detailed description and illustration, an analysis of the karyotype of A. sellowiana, and a discussion of its closest relatives are provided. A key to differentiate the species of Aureliana is also given.

Keywords—Aureliana, IUCN Red List category, karyotype, taxonomy, typification.

Sendtner (1846) included two Witheringia L'Her. species in Flora Brasiliensis: W. sellowiana described by himself and W. aspera Spreng., both with an imprecise locality in southern Brazil (Brasilia australiore). Although Witheringia has been revised twice (Hunziker 1969; Sousa-Peña 2001), neither of them decided the final taxonomic disposition of these names. Hunziker (1969) placed W. sellowiana in Excluded Names assigning it to a Solanum species, probably because of the erroneous anther description made by Sendtner: "poris angustis apicalibus parum apertis in rimam longitudinalem lateralemque continuatis", a diagnostic character of Solanum. The identity of W. aspera is still more uncertain since Hunziker pointed out that its brief description did not allow deciding the real meaning of this name and that the presence of opposite leaves makes its inclusion within Solanaceae unlikely. Sousa-Peña (2001) agreed with Hunziker's statements.

While reviewing type collections of Solanaceae at Paris (P), one of us found fragments of a Museo botanico Berlinense specimen in a small envelope with the handwritten name Athenaea sellowiana Sendtn. (Brasilia: Cubatão, leg. Sellow), and labelled as isotype (image available in http://dsiphoto. mnhn.fr/sonnerat/GBIF/Sol-Orc-JPEG-037/P00371344.jpg). However, this name has never been published. Its original material at B was destroyed during World War II (Hiepko 1987) but there is a photograph (n° 2543) of it in the type photograph collection of the Field Museum, Chicago (F) labelled Witheringia sellowiana Sendtn. as was published in Flora Brasiliensis. According to Art. 9.10 of the International Code of Botanical Nomenclature (McNeill et al. 2006), a lectotypification should be based on the extant fragments from Paris. This material is poor, consisting of the apex of a sterile branchlet, two leaves, and a small immature fruit. As there are no flowers among these fragments, the material at P is also ambiguous because it cannot be accurately identified. Thus, following the Rules (Art. 9.7 of the ICBN), we decided to propose an epitype; the selected epitype was chosen to match as closely as possible the original description as well as the original place of collection.

According to Urban (1893, 1906), Sellow collected in Cubatão three times (3–7 April 1820; 23–29 December 1827;

26 April 1829). For more than a century, no specimen similar to the one described by Sendtner had ever been collected. In the middle of the twentieth century, two peculiar fruiting specimens that fit *W. sellowiana* well, were collected in areas close to Cubatão (Curucutu and Rio Bonito, São Paulo) and were erroneously filed under *Solanum matadori* L. B. Sm. & Downs in herbaria. In recent decades additional materials were gathered with flowers and fruits that are identical to *W. sellowiana*. Considering our reasonably comprehensive knowledge of the South American genera of Solanaceae, the analysis of these specimens permits us to state that they belong to the genus *Aureliana* Sendtn.

This paper deals with the typification of *W. sellowiana* and its transfer to *Aureliana*. Our subsequent fieldwork allowed us to write a complete description of this species and a key to all eight species in the genus, and to provide new karyological information.

Materials and Methods

The present work is based on analysis of fieldwork, herbaria collections, and type specimens deposited at the herbaria B, BHCB, CORD, F, FCQ, HRCB, P, PMSP, R, RB, SP, UEC, and US (Holmgren et al. 1990). Photographs of types of *Aureliana darcyi* and *A. angustifolia* were also seen from the W³ TROPICOS database (http://mobot.mobot.org/W3T/Search/vast.html). Field observations and morphological examination using a stereomicroscopic microscope were carried out on preserved and dried material. We propose a conservation status of *A. sellowiana* following the *Red List Categories and Criteria, version 3.1* (IUCN 2001).

Mitotic chromosomes were examined in squashes of root tips that were obtained from germinating seeds. Seeds were placed on moist filter paper in petri dishes and incubated at 30°C. Root tips, collected after one day, were pretreated in saturated p-dichlorobenzene in water for 2 h at room temperature, fixed in 3:1 ethanol-acetic acid, and stained with alcoholic hydrochloric acid carmine (Snow 1963). To make the different mitotic chromosome measurements, ten metaphase preparations were photographed under phase contrast illumination. The measurements taken for each chromosome pair were as follows: s (short arm), l (long arm), and c (total chromosome length). The arm ratio (r = 1/s) was then calculated and used to classify the chromosomes as recognized by Levan et al. (1964). In addition, the total haploid chromosome length of the karyotype (tl), based on the mean chromosome length, average chromosome length, and average arm ratio were calculated. Karyotype asymmetry was estimated using the indices A, (intrachromosomal asymmetry index) and A, (interchromosomal asymmetry index) of Romero Zarco

TAXONOMIC TREATMENT

Aureliana sellowiana (Sendtn.) Barboza & Stehmann, comb. nov. *Witheringia sellowiana* Sendtn., Fl. Bras. 10: 123. 1846. Brasilia. Cubatão, *Sellow s. n.* (holotype: B, destroyed; lectotype [designed here]: P! ex B). Epitype (designed here): BRAZIL. São Paulo: Mun. São Paulo (Parelheiros), a 300 m de la Estrada Ponte Seca rumbo a Marsilac, 23°53′52″S, 46°43′31″W, 605 m, 15 Apr 2008 (fl, fr), *G. E. Barboza, M. V. Romero and G. Bertone* 2024 (SP!; isoepitypes: BHCB!, CORD!).

Small tree, 3.5-7 m tall, glabrous. Stems dichotomous distally, gray, longitudinally striate, glabrous or with rare dendritic trichomes at the top of foliar buds, the foliar scars rounded, prominent, end of twigs drying blackish. Leaves solitary or in clusters at the top, coriaceous, slightly discolorous, narrowly oblanceolate, sometimes elliptic or oblong, glabrous and somewhat shining on both sides, the margin entire and slightly revolute, the apex acute or acuminate, sometimes falcate, the base attenuate, somewhat decurrent, (4-) 7.3–18.5 \times (0.9-)1.3-2.6 cm, 4.5-7.5 times longer than wide, the venation brochidodromous, the adaxial surface with impressed midrib, abaxially with prominent midrib and drying darker than the upper surface; petioles (0.7–) 1.1–2.5 cm, slightly alate, dark at the base. Inflorescence in terminal or subterminal cymes, sessile, 1-3-florous; pedicels slightly curved, oblique to deflexed, 2.5–2.8 (–3.3) cm, glabrous or with dendritic trichomes at the base. Flower buds ovoid, green, glabrous or with whitish, appressed dendritic or simple trichomes. Calyx green, campanulate or campanulate-rotate, 4-5 mm, 5-lobed, the lobes inconspicuous, obtuse, thick, ca. 0.5 mm, being apparently longer and wider by splitting of the calyx tube, with short glandular trichomes (stalk 2–3-celled, the head multicelled) inside, glabrous outside except for the short sparse dendritic trichomes on the apex. Corolla rotate, fleshy and thick, 15-17.2 mm long, ca. 20 mm diam, lobed nearly to the base, white outside with green spots on the lobes, greenish cream with dark violet spots inside, the lobes $12-12.6 \times 5-5.8$ mm, elliptical, covered with glandular trichomes (stalk 4–9-celled, the head unicellular) inside and glabrous externally except on tips and the involute margins (nonglandular multicelled trichomes), the tip strongly cucullate. Stamens 5, equal, glabrous, 2-3 mm long, anthers oblong, subcaudate (2.7-) 3-3.2 mm long; stapet ca. 1.4 mm tall. Gynoecium with stylar heteromorphism; ovary subglobose, greenish, glabrous, 2 mm tall; nectary yellowish; style clavate, slightly curved, whitish, long style 5.2–5.5 (-6) mm, short style 4.5–4.8 mm; stigma somewhat dilatate, bilobulate, green. Berry globose to subovoid, glabrous, 18-22 mm, green when immature, yellowish at maturity; persistent calyx not accrescent; fruiting pedicels pendent, enlarged at the apex, 3-4 cm long, the pericarp and placenta producing projections into the locule, lacking stone cells. Seeds up to 60 per fruit, yellowish to brownish, discoidal, (3-) 3.2–3.8 \times 2.7–3 mm, the testa thick, foveolate; embryo curved. Figure 1A-L.

Phenology—Flowering and fruiting specimens have been collected from December to April.

Distribution and Habitat—Endemic to southeastern São Paulo state, Brazil, in a restricted area of the Atlantic Forest on the Serra do Mar, between 650–1,100 m. It commonly grows mostly in the montane tropical rainforest in stony soils.

Additional Material Examined—Parque Estadual da Serra do Mar, Núcleo Curucutu, 23°59'16"S, 46°44'0"W, trilha para rio Embu-Guaçu, 19 Dec 1996 (fl, imm. fr), Garcia et al. 956 (UEC); same locality, 13 Dec 1997 (fl, fr), Garcia et al. 1424 (PMSP); Curucutu, 31 Mar 1950 (imm. fr), Pires and Kuhlmann 2831 (SP); Cunha, Parque Estadual da Serra do Mar, 30 Mar 1994 (imm. fr), Baitello 551 (UEC); Reserva Florestal Estadual de Cunha, margem do Rio Bonito, 11/12 Feb 1981 (imm. fr), Kubitzki et al. 81–14 (SP); Núcleo Cunha, trilha do Rio Bonito, 23°13′28″S, 45°02′53″ W, 1,100 m, 19 Mar 1996 (fr), Costa et al. 203 (BHCB); Parelheiros, sítio à esquerda na estrada Eng. Marsilac, sentido Eng. Marsilac, 23°53′46″S, 46°43′40″W, 14 Feb 1995 (fl), Godoy et al. 379 (HRCB, UEC).

Karyology—Figure 2 A shows one of the metaphase figures observed. Mitotic chromosomes of *A. sellowiana* are mediumsized (Fig. 2 A, B; Table 1), with an average chromosome length of $c = 5.34 \pm 0.78$ μm. Small spherical satellites whose diameter is equal to, or less than one-half of, the chromosome diameter, are attached to the short arms of a metacentric chromosome pair. The resulting karyotype formula is 9 m* + 3 sm, and the karyotype obtained, slightly asymmetrical, is represented by an idiogram calculated from the mean values (Fig. 2 B). The asymmetry indices of Romero Zarco (1986) are $A_1 = 0.25$ and $A_2 = 0.14$, the $tl = 64.08 \pm 9.37$ μm and the R = 1.42.

Discussion

Neither the photograph of the destroyed holotype nor the fragments at P provide conclusive data to decide the real identity of this specimen. The statement that the anthers of W. sellowiana are poricide-longitudinal caused this species to be confused with Solanum (Hunziker 1969; Sousa-Peña 2001), so it has been overlooked until now. The diagnosis offers other morphological characters such as the presence of sessile multiflowered cymes, which strongly suggests that it does not belong in Solanum. In addition, the lobed fruiting calyx of W. sellowiana does not fit with any other Witheringia, a genus growing from Mexico to Bolivia (Hunziker 2001; Sousa-Peña 2001), but is similar to that of some genera from Brazil: Athenaea Sendtn., Aureliana Sendtn., Acnistus Schoot, Vassobia Rusby, or Solanum L. The nonaccrescent calyx observed in the photograph at F excludes Athenaea (cfr. Barboza and Hunziker 1989) but not Aureliana, Acnistus, or Vassobia.

The materials collected in flower allowed us to elucidate the disposition of this taxon. Anther dehiscence is strictly longitudinal (Fig. 1 E) and not poricide-longitudinal as it was described; this feature and the presence of a nectary at the ovary base (Fig. 1 I, J) exclude this species from *Solanum*. Stylar heteromorphism (Fig. 1 I, J), the expansion of the filaments functionally related to nectar conduction from the disc to the place of presentation (Fig. 1 E), and the projections of pericarp and placenta into the locule forming a cell-like hollow where seeds are located (Fig. 1 C), common traits in *Aureliana* (Hunziker and Barboza 1990; Hunziker 2001) and clearly observed in the studied material, are sufficient characters for us to conclude that *W. sellowiana* belongs to *Aureliana*.

The most striking characters of this species are its coriaceous, oblanceolate, and generally glabrous leaves, the fleshy and large corolla, and the long pedicels. The corolla with purple spots inside separated by the venation (Fig. 1 E), the fewflowered inflorescences (not more than three flowers), and the presence of dendritic trichomes in the apical shoots (Fig. 1 G) are other distinguishable features shared only with *A. tomentosa. Aureliana sellowiana* is also related to *A. fasciculata* Sendtn. var. *fasciculata* in leaf features (texture and pubescence) differing by its fleshy and thick corolla (vs. membranous and thin corolla), the absence of greenish spots inside the corolla, and the leaf shape (oblanceolate vs. elliptic to ovate).

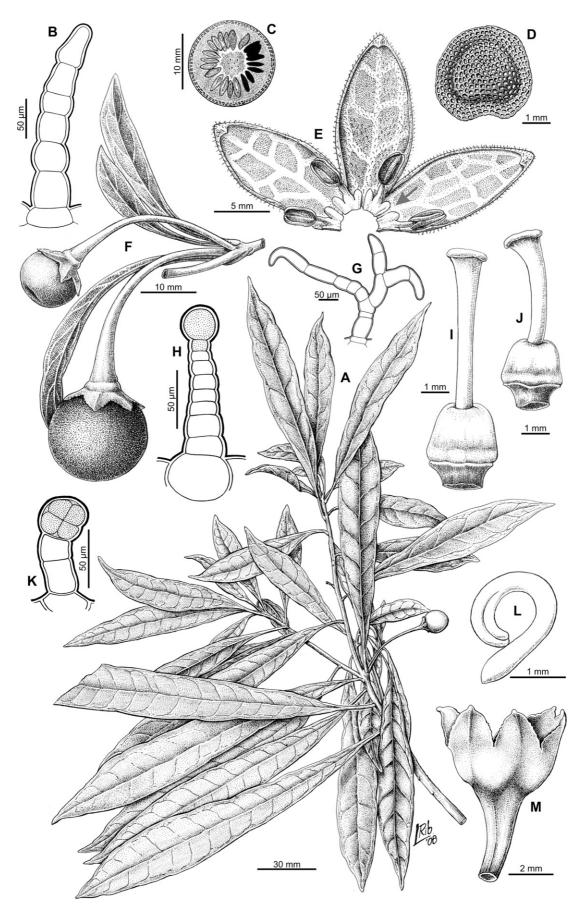
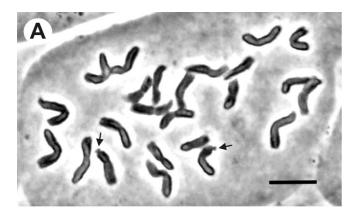


Fig. 1. *Aureliana sellowiana*. A. Branch. B. Nonglandular trichome of the corolla margins. C. Fruit in cross section. D. Seed. E. Corolla in longitudinal section showing the androecium. F. Fruiting branch. G. Dendritic trichome. H. Glandular trichome of the corolla interior. I, J: Gynoecium long- and short-styled respectively. K. Glandular trichome of the calyx interior. L. Embryo. M. Calyx (based on *Barboza et al.* 2024).



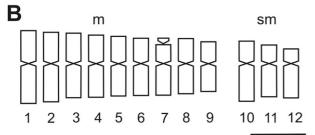


Fig. 2. A. Photomicrograph of a mitotic metaphase of *A. sellowiana*. Arrows indicate satellites, scale bar 5 μ m. B. Idiogram based on mean values, scale bar 5 μ m (From plant grown from seeds from *Barboza et al. 2024*). Abbreviations: m = metacentric chromosome; sm = submetacentric chromosome

In contrast to the habitat of Aureliana velutina which grows in drier areas (Hunziker and Barboza 1990), A. sellowiana inhabits the margin and interior of the wet and shady tropical forest at the Atlantic Forest. Aureliana sellowiana (São Paulo), A. darcyi (Rio de Janeiro), and A. angustifolia (Espírito Santo and Minas Gerais) are the only species in the genus restricted in distribution in Brazil (Carvalho and Bovini 1995; Almeida-Lafetá 2000). Up to now, A. sellowiana has been collected nine times in areas confined to the Núcleos Curucutu and Cunha in the Parque Estadual da Serra do Mar (Cunha), and in the Área de Proteção Ambiental Capivari-Monos (Engenheiro Marsilac, a district of São Paulo). Considering the IUCN (2001) criteria for threatened species, it would be designated as an endangered species due to its geographical range known to exist at no more than five localities, as is also the case of A. darcyi and A. angustifolia. Fortunately, A. sellowiana grows in

Table 1. Measurements of somatic chromosomes of *Aureliana sellowiana*. Abbreviations: s =short arm length; l =long arm length; c =chromosome length; s =standard deviation; * = Chromosome pair with satellite, s =arm ratio.

Pair No.	s ± sd	1 ± sd	c ± sd	R
1	2.98 ± 0.52	3.61 ± 0.58	6.59 ± 1.04	1.22
2	2.83 ± 0.49	3.46 ± 0.51	6.29 ± 0.94	1.24
3	2.75 ± 0.53	3.09 ± 0.49	5.85 ± 1.01	1.14
4	2.58 ± 0.48	3.05 ± 0.49	5.63 ± 0.92	1.20
5	2.47 ± 0.37	2.94 ± 0.51	5.40 ± 0.82	1.20
6	2.29 ± 0.39	2.89 ± 0.56	5.18 ± 0.88	1.27
7*	2.21 ± 0.45	2.86 ± 0.61	5.07 ± 0.94	1.31
8	2.26 ± 0.45	2.73 ± 0.39	5.00 ± 0.76	1.24
9	1.97 ± 0.35	2.53 ± 0.51	4.50 ± 0.79	1.30
10	2.03 ± 0.42	3.41 ± 0.37	5.44 ± 0.74	1.72
11	1.68 ± 0.25	3.01 ± 0.48	4.69 ± 0.71	1.81
12	1.33 ± 0.21	3.11 ± 0.63	4.44 ± 0.79	2.37

areas where natural resources are regulated (Área de Proteção Ambiental) which indicate that it probably has a chance to survive in the wild.

In the last taxonomic revision of Aureliana (Hunziker and Barboza 1990), five species (A. fasciculata with three varieties) were accepted; afterwards, two new species were added from Brazil, A. darcyi (Carvalho and Bovini 1995) and A. angustifolia (Almeida-Lafetá 2000). Unfortunately, none of these species have chromosome counts, despite the relevance that chromosome numbers have in the understanding of evolutionary patterns and processes of any genus. Thus, this is the first chromosome number report in the genus Aureliana. The 2n = 24 (and consequently x = 12) is typical of the subfamily Solanoideae, in which the genus is placed (Hunziker 2001; Olmstead and Bohs 2007; Olmstead et al. 2008), and is the commonest base number in the family. The chromosomes of A. sellowiana are intermediate in size, relative to those of other genera of Solanaceae (Badr et al. 1997). The karyotype asymmetry is also intermediate in the context of the whole family, since in a general survey of the Solanaceae, Badr et al. (1997) reported values of r ranging from 1.17-2.78. In fact, A. sellowiana has submetacentric chromosomes, that are relatively unusual in the Solanaceae (Chiarini and Bernardello 2006; Chiarini and Barboza 2008). Studies involving more species and different cytological techniques are necessary to discuss the position of Aureliana within the subclade Withaninae (sensu Olmstead and Bohs 2007; Olmstead et al. 2008) or within the tribe Capsicinae (sensu Hunziker 2001).

KEY TO THE SPECIES OF AURELIANA

The following analytical key includes all known species of *Aureliana* with additional information on the geographic distribution of the species. Infraspecific taxa of *A. fasciculata* are not treated here.

Calvy lobes equal 0.6-1 mm long (in some A facciculate yar tomoutelle specimens near 2 mm) Anthers oblong

	Э.	Co	nyx lobes equal, 0.0–1 min long (in some A. juscicullu var. lomentetti specimens, near 2 min). Anthers oblong.	
			Inflorescence with up to 12 flowers. Plants glabrous or scarcely pubescent but not velvety	
		6.	Leaves elliptic to ovate or broadly ovate. Fruits with stone cells. Bolivia (Santa Cruz, Pando),	
			Argentina (Misiones), Paraguay (Alto Paraná, Caaguazú, Caazapá, Guairá, Paraguarí, San Pedro),	
			Brazil (Acre, Pernambuco, Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo, Paraná,	
			Santa Catarina, Rio Grande do Sul)	
		6.	Leaves narrowly lanceolate. Fruits without stone cells. Southeastern Brazil (Espírito Santo,	
			Minas Gerais)	
Corolla white with purple spots inside. Apical shoots glabrous or with dendritic trichomes				
7.	Leaves ob	ovat	e or ovate, 6.5–14 cm long, 3–5.3 cm broad, glabrous on the upper surface, tomentose underneath.	
	Pedicels	1.5	-2 cm long. Corolla 8–10 mm long. Southeastern Brazil (São Paulo, Paraná, Santa Catarina)	
7.	Leaves ob	lanc	eolate, 4–18.5 cm long, 0.9–2.6 cm broad, glabrous on both surfaces. Pedicels 2.5–3.3 cm long.	
	Corolla	15-1	17.2 mm long. Southeastern Brazil (São Paulo)	

ACKNOWLEDGMENTS. Fieldwork and herbaria visits were funded by Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET, PIP-02819, PIP-6188), Agencia Nacional de Promoción Científica y Tecnológica (PICT 20196), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) grants. We thank the staff at B, BHCB, CORD, F, FCQ, HRCB, P, PMSP, UEC, R, RB, SP, and US, and especially the curator of P, for sending us digital images of type specimens, and Dr. W. Marcondes-Ferreira and J. Dutilh (UEC), and I. Cordeiro (SP) for their hospitality, logistical assistance, and access to the collections. Dr. L. Ariza Espinar (Museo Botánico Córdoba, Argentina) provided critical logistical support. We are also very grateful to L. Ribulgo for the illustration of A. sellowiana, and Biól. G. Bertone for his invaluable technical assistance in fieldwork.

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