

# *Croton* (Euphorbiaceae) in the State of São Paulo, Brazil: an update

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**ABSTRACT** - (*Croton* (Euphorbiaceae) in the State of São Paulo, Brazil: an update). An updated key for *Croton* species in the State of São Paulo is presented as well as new occurrences of the genus and the reestablishment of *Croton thermanum* Müll. Arg. For those species of *Croton* that were not included in previous studies in the State of São Paulo, we provided: the original publication, synonymy, global geographic distribution, vegetation type, and a representative herbarium collection. This study increases the number of the known species of *Croton* species in São Paulo State to 40 and contributes to the knowledge of the genus in Brazil.

**Keywords:** Flora of São Paulo, floristics, new records, taxonomy

**RESUMO** - (*Croton* (Euphorbiaceae) no Estado de São Paulo, Brasil: uma atualização). É apresentada uma chave de identificação atualizada para as espécies de *Croton* encontradas no Estado de São Paulo, bem como novas ocorrências do gênero e o restabelecimento de *Croton thermanum* Müll.Arg. Para as espécies ainda não tratadas em estudos prévios sobre o gênero no Estado são apresentados: publicação original, sinônimos, distribuição geográfica total e tipo de vegetação de sua ocorrência, além da citação de uma coleção de herbário. O presente estudo aumenta para 40 o número de espécies de *Croton* no Estado de São Paulo e contribui para o conhecimento do gênero no Brasil.

**Palavras-chave:** Flora de São Paulo, florística, novas ocorrências, taxonomia

## Introduction

*Croton* L. (Euphorbiaceae) is considered one of the biggest Angiosperm genera, with about 1.200 species distributed worldwide (Berry *et al.* 2005). In Brazil, *Croton* is also one of the largest genera, with 316 species and a high degree of endemism (BFG 2015). The genus occurs in almost all kinds of habitats but has a great number of species growing in open vegetation and disturbed sites (Gomes-Pompa 1971, Caruzo *et al.* 2011, van Ee *et al.* 2011).

Besides their great morphological variation, species of the genus can be easily recognized by the presence of stellate to lepidote trichomes, clear to reddish latex, basilaminar or acropetiolar glands, senescent leaves that turn orange before abscission, and thyrsoid inflorescences of unisexual flowers (Riina *et al.* 2009).

Here we present an update to the knowledge of *Croton* in São Paulo, a key for all *Croton* species

occurring at the State as well as the reestablishment of *Croton thermanum* Müll.Arg.

## Material and methods

This study was based on field observations and the analysis of herbarium collections from: ESA, MBM, R, RB, SP, SPF, UEC (abbreviations according to Thiers 2018, continuously updated). Type specimens were analyzed through images available mainly at the JSTOR Global Plants website (<http://plants.jstor.org/>). Morphological terms used in the key for the species follows Hickey (1973), Stearn (1992), Webster (1993), and Webster *et al.* (1996).

## Results and Discussion

Although *Croton* continues to be the most diverse genus of Euphorbiaceae in São Paulo (now with 40 species), it is outnumbered by other much

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richer genera of Angiosperms listed in Wanderley *et al.* (2011), such as *Eugenia* (113), *Vernonia* (106) and *Solanum* (102). In São Paulo, species of *Croton* varies from herbs to large trees and occurs in wet to dry forests, ‘cerrados’ and altitude fields. A detailed description of the genus can be found in Caruzo & Cordeiro (2007).

Caruzo & Cordeiro (2007) listed 37 species of *Croton* in São Paulo State. However, the recent discover of *Croton echinocarpus* Müll. Arg. has

increased the number of known species in the State to 38 (Caruzo & Santos 2015). In addition, during taxonomic studies conducted on the genus *Croton* in Brazil, we found new records for São Paulo. Thus, the present work increases the number of species for the State to 40 (table 1), with the occurrence of *Croton chaetophorus* Müll.Arg. and *Croton reitzii* L.B.Sm. & Down in São Paulo. Besides the new records for the State, we also reestablished the name *Croton thermarum* Müll.Arg.

Updated key to the species of *Croton* in São Paulo State (modified from Caruzo & Cordeiro, 2007)

1. Leaves with acropetiolar or basilaminar glands.
    2. Styles 2-fid (with 6 terminal tips)
      3. Prostate subshrubs. Leaves orbiculate to reniform, about 1.0 cm long. .... *C. glechomifolius*
      3. Trees to shrubs, erect. Leaves ovate, ovate-lanceolate to cordiform, 2.0 cm long or more
        4. Inflorescences with proximal cymules of pistillate and staminate flowers, distal ones exclusively staminate
          5. Leaves ovate-lanceolate. Stipitate acropetiolar glands ..... *C. macrobothrys* subsp. *macrobothrys*
          5. Leaves ovate to cordiform. Sessile acropetiolar glands
            6. Plants with stellate trichomes. Bracts triangular. Pistillate flowers with petals reduced to a conspicuous globose to patelliform glands ..... *C. gracilipes*
            6. Plants with dendritic trichomes, adpressed-stellate or stellate. Bracts lanceolate. Pistillate flowers with filiform petals.
              7. Leaves ovate. Capsule obovate, strongly trigone; seeds subglobose with a smooth testa ... *C. piptocalyx*
              7. Leaves cordiform. Capsule subglobose to globose; seeds globose with a verrucose to costate testa.
                8. Stipules subulate, acute apex, not foliaceous. Capsule echinate-muricate ..... *C. echinocarpus*
                8. Stipules ovate, acuminate apex, foliaceous. Capsule smooth ..... *C. urucurana*
    4. Inflorescences with proximal cymules pistillate and distal ones staminate.
      9. Leaf margin entire to finely serrate. Pistillate flowers subcampanulate; sepals equal in size. Columella with three prominent inflated lobes.
        10. Inflorescences congested. Petals of pistillate flowers filiform ..... *C. reitzii*
        10. Inflorescences lax. Petals of pistillate flowers reduced to globose glands.
          11. Indumentum glabrescent. Stipules deltoid. Leaves with stipitate acropetiolar glands. Staminate flowers pedicellate ..... *C. leptobotryus*
          11. Indumentum pubescent. Stipules lanceolate. Leaves with sessile acropetiolar glands. Staminate flowers sessile ..... *C. sanctae-crucis*
      9. Leaf margin serrate to dentate. Pistillate flowers subcampanulate to campanulate, sepals unequal in size. Columella lacking prominent inflated lobes
        12. Leaf margin dentate. Inflorescence axis without flowers between proximal distal cymules; bracts without glands ..... *C. lundianus*
        12. Leaf margin serrate. Inflorescence axis with proximal distal cymules contiguous; bracts with lageniform glands.
          13. Young branches pubescent, stellate trichomes. Bracts with sessile lageniform glands. Ovary pilose ..... *C. glandulosus*
          13. Young branches hirsute, stellate and stellate-porrect trichomes. Bracts with shortly stipitate lageniform glands. Ovary hirsute ..... *C. hirtus*
2. Styles 4-fid or more (12 or more terminal tips)
  14. Inflorescences with pistillate cymules proximal and staminate distal

15. Young branches pubescent. Leaves with entire margin, without glands; venation eucamptodromous; basilaminar glands adpressed, sometimes covered by trichomes. Pistillate petals subulate, with glands at the apex ..... *C. thermarum*
15. Young branches hirsute. Leaves with dentate margin, with glands in the sinuses; venation cladodromous; basilaminar or acropetiolar glands not adpressed and not covered by trichomes. Pistillate petals absent or inconspicuous
16. Inflorescence axis without flowers between proximal distal cymules. Pistillate flowers sessile; sepals 6 ..... *C. sclerocalyx*
16. Inflorescence axis with proximal distal cymules contiguous. Pistillate flowers pedicellate; sepals 5 ..... *C. antisiphiliticus*
14. Inflorescences with proximal cymules of pistillate and staminate flowers, distal cymules of staminate flowers.
17. Leaf glands sessile
18. Leaves ovate, base cuneate to slightly truncate. Staminate flowers campanulate. Pistillate flowers pedicellate; calyx lobes sometimes with dark brown indument ..... *C. rottlerifolius*
18. Leaves ovate to ovate-lanceolate, base cordate Staminate flowers rotate. Pistillate flowers subsessile; calyx lobes with whitish indument ..... *C. sphaerogynus*
17. Leaf glands stipitate
19. Plants with lepidote trichomes
20. Indument rufous-silvery; branchlets angular. Pistillate flowers flask-shaped; calyx lobes not accrescent in fruit ..... *C. salutaris*
20. Indument silvery; branchlets cylindrical. Pistillate flowers campanulate; calyx lobes strongly accrescent in fruit ..... *C. hemiargyreus*
19. Plants with stellate, adpressed-stellate or dendritic trichomes
21. Stamens 80-130 ..... *C. vulnerarius*
21. Stamens 18-60
22. Leaves widely elliptical to obovate; margin crenate. Stamens ca. 18. Pistillate flowers reduplicate-valvate; sepals rounded ..... *C. priscus*
22. Leaves ovate to cordate; margin serrate. Stamens 50-60. Pistillate flowers valvate; sepals ovate to ovate-lanceolate
23. Pistillate flowers slightly campanulate, sessile to subsessile; calyx lobes ovate, foliaceous, ca. 8 mm long; styles slightly joined at the base ..... *C. alchorneicarpus*
23. Pistillate flowers rotate, usually pedicellate, rarely subsessile; calyx lobes ovate-lanceolate, ca. 3 mm long; styles free ..... *C. celtidifolius*
1. Leaves without glands (except in *C. organensis*, where the glands are usually maculate and very difficult to see)
24. Staminate flowers with three cuculate sepals and the other two flat. Pistillate ones with three bigger and laciniate sepals and the other two inconspicuous and entire.
25. Subshrubs with xylopodium. Leaves oblong, lanceolate, orbiculate to ovate. Seeds with smooth testa ..... *C. didrichsenii*
25. Subshrubs to shrubs without xylopodium. Leaves cordate, widely elliptical, lanceolate to ovate-lanceolate. Seeds with reticulate testa
26. Indument whitish to ferrugineous; styles 4-fid (12 terminal tips) ..... *C. triqueter*
26. Indument whitish and darkish; styles 2-fid (6 terminal tips) ..... *C. fuscescens*
24. Staminate flowers with five flat sepals. Pistillate ones with 5 entire sepals of the same size
27. Styles 2-fid (with 6 terminal tips)
28. Plants from 'cerrado' *s.s.*, indument exclusively of stellate trichomes
29. Stamens ca. 18. Capsule globose, pilose to hirsute. Seeds smooth ..... *C. grandivelus*
29. Stamens ca. 11. Capsule subglobose to ellipsoid, glabrescent. Seeds slightly warty ..... *C. pedicellatus*
28. Plants from grasslands or high montain grasslands, indumentum of stellate, adpressed-stellate or lepidote trichomes

30. Leaves covered by stellate trichomes on the upper surface and adpressed-stellate or lepidote trichomes on the lower surface.
31. Leaves lanceolate. Pistillate flowers campanulate; calyx lobes lanceolate to spatulate; styles 2-fid to twice 2-fid ..... *C. serpyllifolius*
31. Leaves elliptical to ovate-lanceolate. Pistillate flowers subcampanulate; calyx lobes ovate to rounded; styles always 2-fid ..... *C. ceanothifolius*
30. Leaves covered only by lepidote trichomes
32. Leaves usually with upper surface glabrous and lower surface lepidote. Pistillate flowers campanulate, calyx lobes ovate-lanceolate to oblong ..... *C. dichrous*
32. Leaves lepidote on both surfaces. Pistillate flowers subcampanulate, calyx lobes elliptical, ovate to obovate ..... *C. erythroxyloides*
27. Styles 4-fid or more (12 or more terminal tips)
33. Pistillate flowers with sepals covered by glandular trichomes
34. Bracts entire, lanceolate-rhombic; without glandular trichomes. Sepals of pistillate flowers entirely covered by glandular trichomes ..... *C. chaetophorus*
34. Bracts lacinate, linear; margin with glandular trichomes. Sepals of pistillate flowers with glandular trichomes restricted to the margin
35. Leaves tomentose on lower surface, elliptic to ovate-lanceolate, venation eucamptodromous. Stipules lacinate ..... *C. serratifolius*
35. Leaves pubescent to glabrescent on lower surface, rhombic to obovate, venation acrodromous. Stipules entire ..... *C. fuscus*
33. Pistillate flowers with the sepals without glandular trichomes
36. Inflorescence congested, comose. Pistillate sepals lanceolate, margin glandular-lacerate; petals inconspicuous ..... *C. heterodoxus*
36. Inflorescence lax, not comose. Pistillate sepals oblong to ovate-lanceolate, margin entire; petals filiform or absent
37. Branchlets flattened. Staminate flowers campanulate to subcampanulate. Pistillate flowers sessile to subsessile; petals absent
38. Stipules subulate, margin with glands. Inflorescences with all cymules of the same type. Pistillate flowers campanulate, calyx lobes ovate to ovate-lanceolate ..... *C. compressus*
38. Stipules linear, margin without glands. Inflorescences with proximal cymules of pistillate and staminate flowers, distal cymules of staminate flowers. Pistillate flowers flask-shaped, calyx lobes rhomboidal ..... *C. organensis*
37. Branchlets cylindrical. Staminate flowers rotate to subcampanulate. Pistillate flowers pedicellate; petals filiform
39. Trees covered by stellate, adpressed-stellate and trichomes. Pistillate flowers rotate. Capsule globose, verrucose. Seeds globose, smooth ..... *C. floribundus*
39. Shrubs covered by lepidote trichomes. Pistillate flowers campanulate. Capsule subglobose, smooth. Seeds oblong, slightly ribbed ..... *C. tricolor*

***Croton chaetophorus*** Müll.Arg., Linnaea 34: 130. 1865. Type: BRAZIL. “*Brasilia meridionalis*”, s.d., A.F. Regnell, s.n. (syntype: B [n.v.]); idem, F. Sellow, s.n. (s: B [n.v.]); idem, L. Riedel, s.n. (syntype: B [n.v.]). (Illustrations in Smith *et al.* 1988)

Shrubs about 1.5 m tall, in open vegetation. Occurs in south (PR, SC) and southeastern Brazil (MG, SP).

In the previous treatment of *Croton* from the State of São Paulo (Caruzo & Cordeiro 2007),

specimens of *C. chaetophorus* were misidentified as *C. serratifolius* Baill. (e.g. Paula-Souza *et al.* 3655). In fact, *C. chaetophorus* is similar to *C. serratifolius*, once both species have stellate trichomes on branchlets and leaves, glandular trichomes on pistillate flower calyx lobes and styles 4-fid. However, the two species can be differentiated by leaf shape (ovate to ovate-lanceolate in *C. chaetophorus* vs. elliptic to oblong in *C. serratifolius*) and stipules (lacinate with glandular trichomes at the base in *C. chaetophorus* vs. entire

Table 1. Updated list of *Croton* from São Paulo.

Species	Voucher number
<i>Croton alchorneicarpus</i> Croizat	Riina 1532 (SP)
<i>C. antisiphiliticus</i> Mart.	Duarte 53 (SP)
<i>C. ceanothifolius</i> Baill.	Caruzo 70 (SP, SPF, WIS)
<i>C. celtidifolius</i> Baill.	Santos 40 (SP)
<i>C. chaetophorus</i> Müll.Arg.	Paula-Souza 3655 (ESA, HUEFS, SP)
<i>C. compressus</i> Lam.	Rossi 1090 (SP, WIS)
<i>C. dichrous</i> Müll.Arg.	Caruzo 69 (SP, SPF, WIS)
<i>C. didrichsenii</i> Webster	Souza 2422 (BHCB, ESA, FUEL, IAN, SPSF, MBM, PEL, RB, SP)
<i>C. echinocarpus</i> Müll.Arg.	Santos 2 (SP)
<i>C. erythroxyloides</i> Baill.	Caruzo 74 (SP, SPF, WIS)
<i>C. floribundus</i> Spreng.	Santos 3 (SP)
<i>C. fuscescens</i> Spreng.	Caruzo 1 (SP)
<i>C. fuscus</i> (Didr.) Müll.Arg.	Kuhlmann s.n. (SP 69956)
<i>C. glandulosus</i> L.	Caruzo 25 (SP)
<i>C. glechomifolius</i> Müll.Arg.	Chung 127 (SP)
<i>C. gracilipes</i> Baill.	Santos 44 (SP)
<i>C. grandivelus</i> Baill.	Caruzo 34 (SP)
<i>C. hemiargyreus</i> Müll.Arg.	Santos 42 (SP)
<i>C. heterodoxus</i>	Elias 258 (SP)
<i>C. hirtus</i> L'Hér.	Torres 116 (IAC, SP)
<i>C. leptobotryus</i> Müll.Arg.	Mello-Silva 41 (SP, SPF)
<i>C. lundianus</i> (Didr.) Müll.Arg.	Caruzo 64 (SP)
<i>C. macrobothrys</i> subsp. <i>macrobothrys</i> Baill.	Santos 32 (SP)
<i>C. organensis</i> Baill.	Caruzo 82 (SP, SPF, WIS)
<i>C. pedicellatus</i> Kunth	Pinheiro 727 (HRCB, SP)
<i>C. piptocalyx</i> Müll.Arg.	Caruzo 79 (SP, WIS)
<i>C. priscus</i> Croizat	Caruzo 63 (SP)
<i>C. reitzii</i> L.B.Sm. & Downs	Cielo-Filho 1149 (SP, SPSF)
<i>C. rottlerifolius</i> Baill.	Santos 41 (SP)
<i>C. salutaris</i> Casar.	Caruzo 81 (SP, SPF, WIS)
<i>C. sanctae-crucis</i> S. Moore	Pereira-Noronha 1542 (SP, UEC)
<i>C. sclerocalyx</i> (Didr.) Müll.Arg.	Caruzo 43 (SP)
<i>C. serpyllifolius</i> Baill.	Souza 7030 (ESA, SP)
<i>C. serratifolius</i> Baill.	Souza 8807 (ESA, SP)
<i>C. sphaerogynus</i> Baill.	Caruzo 65 (SP, WIS)
<i>C. thermanum</i> Müll.Arg.	Garcia 687 (HRCB, PMSP, SP, SPF, UEC)
<i>C. tricolor</i> Klotzsch ex Baill.	Caruzo 85 (SP)
<i>Croton triqueter</i> Lam.	Caruzo 27 (SP)
<i>C. urucurana</i> Baill.	Santos 5 (SP)
<i>C. vulnerarius</i> Baill.	Santos 56 (SP)

with glandular trichomes along the margin in *C. serratifolius*).

Selected specimen examined: BRAZIL. SÃO PAULO: Itararé, 17 km de Itararé para Bom Sucesso de Itararé, 13-XI-2003, *J. Paula-Souza et al.* 3655 (ESA, HUEFS, SP).

***Croton echinocarpus*** Müll.Arg., *Linnaea* 34: 88. 1865. *Croton verrucosus* Radcl.–Sm. & Govaerts, *Kew Bull* 52: 198. 1997. nom. super. Type: BRAZIL. *s.d., s.col., s.n.* (holotype: G-DC 00311425!). (Figures in Caruzo & Santos 2015)

*Croton echinocarpus* is endemic from the Atlantic Rain Forest and is found mainly in montane wet forests from southeastern Brazil (ES, MG, RJ, SP) (Silva *et al.* 2017). The ornamentation of the epicarp (echinate-muricate, with projections ending in a stipitate-multiradiate trichome) is a diagnostic characteristic to the species.

Among all species of *Croton* from São Paulo State, *C. echinocarpus* is most similar to *C. celtidifolius* Baill. However, both species can be separated by their leaf glands (sessile in *C. echinocarpus* vs. stipitate to shortly stipitate in *C. celtidifolius*), styles division (2-fid and united in *C. echinocarpus* vs. 4-fid and free in *C. celtidifolius*), and epicarp ornamentation (echinate-muricate in *C. echinocarpus* vs. warty in *C. celtidifolius*).

Selected specimen examined: BRAZIL. SÃO PAULO: Atibaia, 28-III-2014, *R.F. Santos* and *O.L.M. Silva* 2 (SP).

***Croton reitzii*** L.B.Sm. & Downs, *Sellowia* 11: 152. 1959. Type: BRAZIL. Santa Catarina: Canoinhas, 19 km ao oeste de Canoinhas no caminho para Porto União, 17-XII-1956, *L.B. Smith & R. Reitz* 8590 (holotype: US 2249814!; isotypes: K 000254430, NY 00262942, R000200949, UC 1079899). (Illustrations in Smith *et al.* 1988)

Shrubs about 1.5 m tall, growing along borders of Araucaria forest, rarely in open vegetation, in south (PR, RS, SC) and southeastern Brazil (SP). The leaves with a pair of sessile glands and the inflorescences congested are important characteristics for species recognition (see illustrations in Smith *et al.* 1988). Smith *et al.* (1988) recorded *Croton reitzii* for southern Brazil. Here we first record the species for São Paulo State, extending its distribution range.

The species is most morphologically similar to *C. lanatus* (a species endemic to southern Brazil),

however both species can be distinguished by leaf shape (lanceolate in *C. reitzii* vs. ovate to ovate-lanceolate in *C. lanatus*), bracts morphology (without glands at the base in *C. reitzii* vs. with a pair of glands at the base in *C. lanatus*), and inflorescences (congested in *C. reitzii* vs. lax in *C. lanatus*).

Selected specimen examined: BRAZIL. SÃO PAULO: Itapeva, 30-IX-2010, *R. Cielo-Filho, J.B. Baitello* and *C.R. Lima* 1149 (SP, SPSF).

***Croton thermarum*** Müll.Arg., *Fl. Bras.* 11(2): 151. 1873. Type: BRAZIL. Minas Gerais: “prope Caldas, in campis juxta thermas”, 1847, *A.F. Regnell* 1084 (holotype: G 00434665!; isotypes: BR 0000008760623!, BR 0000008760654!, P00623517!, S 0712769!, S R-10582!, US 00109775!, US 00902149!). (Illustrations in Caruzo & Cordeiro 2007)

Shrubs to subshrubs mainly from open vegetation in Brazil (MG, PR, SP). The species can be recognized due to its basilaminar glands and the presence of rosulate trichomes covering the ovary and fruit.

*Croton thermarum* was synonymized to *C. lanatus* Lam. var. *lanatus* by Caruzo & Cordeiro (2007), mainly due to their similar trichomes in branches, and leaves with basilaminar glands extremely adpressed. However, both species can be differentiated by styles division (4-fid in *C. thermarum* vs. 2-fid in *C. lanatus* var. *lanatus*) and ovary trichomes (rosulate in *C. thermarum* vs. stellate in *C. lanatus* var. *lanatus*). In addition, *C. lanatus* var. *lanatus* occurs in sympatry with *C. thermarum* only in Paraná State, where its northern boundary of distribution is located. Therefore, we here reestablished the name *C. thermarum*.

Selected specimen examined: BRAZIL. SÃO PAULO: São Paulo, VII-1995, *R.J.F. Garcia et al.* 687 (HRCB, PMSF, SP, SPF, UEC).

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