



# An overview of recent taxonomic studies on Euphorbiaceae s.l. in Brazil

## *Panorama dos recentes estudos taxonômicos em Euphorbiaceae s.l. no Brasil*

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### Abstract

The Euphorbiaceae *sensu lato* are distributed mainly in the tropics, in various types of vegetation and habitats, being one of the largest, most complex and diverse families of angiosperms. It has recently been divided into four families, according to classification systems based on molecular phylogeny: Euphorbiaceae *sensu stricto*, Phyllanthaceae, Putranjivaceae, and Picrodendraceae. There is a proposition to establish Peraceae still under discussion. There were also changes in the taxonomic position of genera widely distributed in the Brazilian territory, such as *Amanoa*, *Drypetes*, *Pera*, *Phyllanthus*, *Podocalyx*, *Pogonophora*, and *Richeria*, among others. In addition, new species have been proposed and the limits of taxa distribution are expanding in Brazil. Thus, the authors provide an overview of recent studies and advances in the taxonomy of Euphorbiaceae s.l. in the Northern, Northeastern, Southeastern and Southern regions of Brazil, concentrating on review works and regional floras, as well as the changes that resulted in setting a new taxonomic family.

**Key words:** *Croton*, *Phyllanthus*, taxonomy of Phanerogams, plant distribution.

### Resumo

As Euphorbiaceae *sensu lato* distribuem-se especialmente nos trópicos, nos mais variados tipos de vegetação e habitats, sendo uma das maiores, mais complexas e diversificadas famílias das Angiospermas. Foi recentemente dividida em quatro famílias e segundo os atuais sistemas de classificação, baseados em estudos filogenéticos envolvendo dados moleculares, está assim classificada: Euphorbiaceae *sensu stricto*, Phyllanthaceae, Putranjivaceae e Picrodendraceae, havendo uma proposição de estabelecer Peraceae, táxon ainda em discussão. Houve também mudanças no posicionamento taxonômico de gêneros de ampla distribuição no território brasileiro, tais como *Amanoa*, *Drypetes*, *Pera*, *Phyllanthus*, *Podocalyx*, *Pogonophora* e *Richeria*, entre outros. Além disso, novas espécies vêm sendo propostas e a amplitude dos limites de distribuição de diversos táxons vem aumentando no Brasil. Diante do exposto, os autores fornecem um panorama geral dos estudos mais recentes e avanços na taxonomia de Euphorbiaceae s.l. nas regiões Norte, Nordeste, Sudeste e Sul do país, concentrando-se nos trabalhos de revisão e floras regionais, bem como nas mudanças que resultaram em nova configuração taxonômica da família.

**Palavras-chave:** *Croton*, *Phyllanthus*, taxonomia de fanerógamos, distribuição de plantas.

### Introduction

The Euphorbiaceae is composed of 334 genera (Webster 1994) and over 8,000 species (Radcliffe-Smith 2001), which are distributed mainly in the tropics in the several types of vegetations and habitats. It is one of the most complex, large and diverse families of Angiosperms. Wurdack *et al.* (2004) consider Euphorbiaceae *sensu lato* as a pantropical family, composed of 340 genera and approximately 8,000–9,000 species.

This family is considered as one of the most important Angiosperm groups, especially for comprising genera such as *Hevea* Aublet and *Manihot* Miller. According to Schultes (1987), the rubber-tree (*Hevea brasiliensis* (Willd. ex A. Juss.) Muell.Arg.) has drastically changed human life within a single century, because it is a natural source of rubber, whereas the manioc, also known in Brazil as “aipim”, “macaxeira” or “cassava”, (*Manihot esculenta* Crantz) is among the 13 most important human foods.

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Many authors studied the taxonomy of this family, standing out Jussieu (1824), Baillon (1858), Bentham (1878, 1880) Mueller (1873), Hutchinson (1969), Jablonski (1967), and Pax & Hoffmann (1914, 1931). Recently, a significant contribution was made by Webster (1975, 1987, 1994), which was mainly related to the family's classification and to a revision of members of the Euphorbiaceae in the New World (Webster 1993; Webster & Armbruster 1991).

Recently, the family has been through several taxonomic changes, mainly based on phylogenetic studies with molecular data (APG II 2003; Wurdack *et al.* 2004, 2005; APG III 2009), with marked differences in relation to the traditional classification revised and proposed by Webster (1994), in which Euphorbiaceae was divided into five subfamilies.

However, although the Euphorbiaceae *s.l.* have been studied by a group that comprises botanists from several countries, including Brazil, and carries out research in taxonomy, anatomy, phytochemistry, economic botany, and molecular systematic, which already resulted in the division of the family into four (APG II 2003), the knowledge of this family still has considerable gaps, even regarding morphology. Webster (1987) emphasizes that to propose a safer classification for this family, at least detailed morphological and anatomical studies involving many of its genera are required.

This situation is also observed in Brazil, where many genera of Euphorbiaceae *s.l.* exhibit high number of species, such as *Phyllanthus* L., *Mabea* Aublet, *Dalechampia* Plumier ex L., and *Croton* L. These genera still have confusing and outdated taxonomy in some regions of the country, though some advancements have been made in the past years, mainly with the publication of the Species List of the Brazilian Flora (Cordeiro *et al.* 2010; Secco *et al.* 2010).

Therefore, the present study aims at presenting an overview of the most recent studies on Euphorbiaceae *s.l.* in four Brazilian regions as well as changes in the classification of the group, and at pointing out research opportunities that could lead to a more complete knowledge, in particular of the less studied genera.

### **Euphorbiaceae Systematics in the Light of Modern Classification Systems**

In Engler's system (1964) the Euphorbiaceae were classified in the class Dicotyledoneae, subclass Archychlamydeae, order Geraniales and suborder Euphorbiineae.

Cronquist (1981) classified them in the class Magnoliopsida, subclass Rosidae, order Euphorbiales.

Webster (1975) proposed an infrafamilial classification for the Euphorbiaceae, subdividing it into five subfamilies, which were separated into two groups, according to the number of ovules per ovary locule: Phyllanthoideae and Oldfieldioideae, both with two ovules and Acalyphoideae, Crotonoideae and Euphorbioideae, with one ovule.

In a revised and extended classification, Webster (1994) proposed that Euphorbiaceae *s.l.* encompasses five subfamilies: Phyllanthoideae, Oldfieldioideae, Crotonoideae, Acalyphoideae, and Euphorbioideae. He also proposed new tribes and subtribes in the same study.

However, according to the classification system proposed by the Angiosperm Phylogeny Group (APG II 2003), there are no molecular evidences that allow maintaining Euphorbiaceae *s.l.* as a single group. The family was then divided into four: Euphorbiaceae *sensu stricto*, comprising the subfamilies with uniovulate ovary locules (Euphorbioideae, Crotonoideae, and Acalyphoideae); Phyllanthaceae, including the Phyllanthoideae (bioovulate ovary locules), Picrodendraceae, including the Oldfieldioideae (bioovulate ovary locules) and Putranjivaceae (bioovulate ovary locules, comprising *Drypetes* Vahl and *Putranjiva* Wall.).

Wurdack *et al.* (2005), using molecular data of the plastidial regions *rbc-L* and *trnL-F*, assessed the circumscription of Euphorbiaceae *s.s.* (Acalyphoideae, Crotonoideae and Euphorbioideae), as well as the monophyly of the suprageneric taxa recognized in recent classifications. Hence, they proposed two new subfamilies in Euphorbiaceae *s.s.*: Peroideae and Cheilosoideae. These studies corroborated the findings of the Angiosperm Phylogeny Group (APG II 2003), i.e., only the subfamilies with uniovulate ovary locules (Euphorbioideae, Acalyphoideae and Crotonoideae) are considered as Euphorbiaceae *s.s.*; they re-established Peroideae Baill. ex Hassk. as a subfamily and admitted that the classification of Euphorbiaceae *s.s.* needs revision.

Euphorbiaceae *s.s.* and the other families segregated from Euphorbiaceae *s.l.* are included in Malpighiales, according to the Angiosperm Phylogeny Group (APG II 2003; APG III 2009), Wurdack *et al.* (2005) and Wurdack & Davis (2009). Hence, it was necessary to move some genera to independent families, as for example, *Amanoa* Aublet (to Phyllanthaceae), *Podocalyx* Klotzsch (to Picrodendraceae), and *Drypetes* (to Putranjivaceae). Those changes have been debated and have not always received the approval of specialists in

Euphorbiaceae, as in the case of *Pera* Mutis, in Peraceae, which still needs further studies according to APG III (2009).

This division of Euphorbiaceae *s.l.* into four families was maintained by the Angiosperm Phylogeny Group (APG III 2009), which stated also that the recognition of Peraceae Klotzsch would be necessary to maintain Euphorbiaceae as a monophyletic group, since Rafflesiaceae would be placed between the subfamilies Peroideae and Acalyphoideae. Yet it would depend on future studies, what would hinder the tentative establishment of the family (Peraceae).

Judd *et al.* (2009) recognized four families: Euphorbiaceae *s.s.*, Phyllanthaceae, Picrodendraceae, and Putranjivaceae, all in the clade Malpighiales; Phyllanthaceae exhibits two ovules per locule and seeds without aril. Picrodendraceae also has two ovules per locule, but it does not have divided styles and nectariferous disk.

Wurdack & Davis (2009) proposed the elevation of Peroideae to the family status (Peraceae). Although approved by the APWeb, this proposal is still under debate (Stevens 2001). Reveal & Chase (2011) did not consider Peraceae as a family, considering it as a synonym of Euphorbiaceae.

### Geographic Distribution of Euphorbiaceae

Euphorbiaceae *s.s.* has pantropical distribution, with higher occurrence in tropical regions. According to Judd *et al.* (2009), this family is composed of 222 genera and 6,100 species. These authors state that Phyllanthaceae has predominantly tropical distribution, with 55 genera and 1,745 species. According to Souza & Lorenzi (2008), Picrodendraceae is a pantropical taxon and has approximately 30 genera and 100 species, and Putranjivaceae is predominantly paleotropical, with only three genera and approximately 200 species.

Wurdack & Davis (2009) stated that Euphorbiaceae *s.s.* is the largest Malpighiales family, with more than 246 genera and approximately 6,300 species.

### Euphorbiaceae Studies in Brazil

*Croton* L. is the most studied genus of Euphorbiaceae *s.l.* in Brazil and abroad, not only from the perspective of classic taxonomy, but also of phylogenetic systematics made mainly with molecular data. Complex genera such as

*Phyllanthus*, *Dalechampia*, *Manihot*, and *Mabea* still need updated taxonomic revision, aiming at a better knowledge of their species boundaries.

Next, we provide a general overview of what has been studied on the matter by different research groups in Euphorbiaceae *s.l.* in the northern, northeastern, southeastern, and southern regions of Brazil.

#### I. Euphorbiaceae in the Northern Region

In the Brazilian Amazon, pioneer studies were led by Jacques Huber, Adolpho Ducke, and Walter Egler, with contributions by Murça Pires and William Rodrigues. From the 1980s on, there has been great increase in Euphorbiaceae research in the region, mainly involving the subfamily Crotonoideae (*sensu* Webster), starting with studies by Secco (1985), discussing varieties of *Sagotia racemosa* Baill. Secco (1987) assessed systematic and evolutionary aspects of *Sandwithia* Lanj., and compared them with those of *Sagotia* Baill. and *Anomalocalyx* Ducke. Secco (1988) described the second species of *Sandwithia*, *S. heterocalyx* Secco, an uncommon taxon that exhibits a pistillate flower with free calyx, contrary to the genus' pattern.

In the 1990s stands out the study by Secco (1990a), who revised *Anomalocalyx*, *Dodecastigma* Ducke, *Pausandra* Radlk., *Pogonophora* Miers ex Bentham, and *Sagotia*, providing a consistent update of *Pausandra*, a genus with very confusing taxonomy until then, in particular because of its sparse distribution in the Amazon and its little conspicuous, usually deciduous flowers. The revision of *Richeria* Vahl (Secco & Webster 1990) invalidated the varieties proposed previously for *R. grandis* Vahl, as well as updated the synonymy. Patterns of geographic distribution of some Crotonoideae in the Amazon were presented by Secco (1990b; 1993a), who assessed mainly *Pausandra* species and started a study on *Croton* species that occur in the Brazilian Amazon. In his study, he described some liana species, comparing them with *C. pullei* Lanj., whose palynological aspects continued to be discussed by Carreira *et al.* (1996). A taxonomic treatment for *Nealchornea* Huber was made by Secco (1997).

Starting the studies on Alchorneae (Hurusawa) Hutchinson, Secco (1993b) proposed the species *Alchornea fluviatilis* Secco, collected in the Carajás Mountain Range (state of Pará) and in the Pindaré River (state of Maranhão); the species is uncommon in the genus because it is monoecious. Later,

analyzing collections from Bolivia, he described *Alchornea anamariae* Secco and proposed a new combination for *Alchornea* Swartz, based on *Conceveiba pubescens* Britton, later renamed as *Alchornea brittonii* Secco. This research resulted in a revision of the Neotropical Alchorneae, published in *Flora Neotropica* (Secco 2004a), updating *Aparisthium* Endlicher, *Alchornea*, and *Conceveiba* Aublet, resulting in a total of 37 species. Next, Secco & Giulietti (2007) discussed aspects of the biology of *Conceveiba guianensis* Aublet collected in the Mocambo Reserve (Belém, Pará), in which only individuals with pistillate flower, fruits, and seedlings were found.

An update of the taxonomy and phytogeography of *Hevea* was proposed by Pires *et al.* (2002). Taxonomic treatments were also made for *Alchorneopsis* Muell. Arg., *Cleidion* Blume and *Polyandra* Leal (Secco 2001), *Adenophaedra* (Muell. Arg.) Muell. Arg., and *Tetrorchidium* Poeppig (Secco 2003), as well as for 15 Euphorbiaceae genera of the Ducke Reserve (Secco 2005). In addition, other studies on Euphorbiaceae present in Neotropical floras are *Flora of Venezuelan Guiana* (Secco *in Webster et al.* 1999), *Flora of the Ducke Reserve* (Secco & Cordeiro 1999), *Checklist of Flora of Acre* (Secco *et al.* 2008b), *Checklist of the Plants of the Guiana Shield*, *Checklist of Flora of Bolivia* (Secco *et al. in press*), *Euphorbiaceae of the Flora of Caxiuanã Reserve* (Trindade & Secco 2009), and *Rare Plants of Brazil* (Secco & Rosário 2009). A taxonomic update of the rubber-tree *Hevea brasiliensis* was made by Secco (2008a), by request of EPAMIG (Agricultural Research Company of Minas Gerais).

Secco (2008b) concluded the revision of *Croton* species that occur in the Brazilian Amazon, including most of those addressed by Mueller (1873) and bringing about taxonomic novelties such as *Croton faroensis* R. Secco, *C. dissectistipulatus* R. Secco (Secco 2004b), an uncommon species because it has only three stamens, *C. subasperrimus* R. Secco, P. Berry & C. Rosário, *C. diasii* Pires *ex* Secco & P.E. Berry, and *C. trombetensis* Secco, P.E. Berry & N. Rosa. He also recorded new occurrences in the region, such as *Croton gossipiifolius* Vahl, *Croton nervosus* Kl., *Croton sampatik* Muell. Arg., *C. guianensis* Aublet, *C. spiraeifolius* Jabl., *C. urucurana* Baill., *C. draconoides* Muell. Arg., *C. mollis* Benth., *C. tessmannii* Mansf., and *C. schiedianus* Schl. Guimarães & Secco (2009) updated the species of *Croton* section *Cyclostigma* and *Croton* section *Luntia* subsection *Matourense* (Euphorbiaceae s.s.)

that occur in the Brazilian Amazon by including *Croton urucurana* Baill., *C. draconoides* Muell. Arg., *C. trombetensis* Secco; Berry & Rosa, *C. sampatik* Muell. Arg., *C. palanostigma* Kl., *C. pullei* Lanj., and *C. matourensis* Aublet.

Currently, Euphorbiaceae research in the Amazon is focused on *Pera* (see Bigio & Secco 2012, in this volume), a genus which had never before been subjected to revision, and which still has a confusing and outdated taxonomy, in addition to *Micrandra* Benth., *Dalechampia* and *Amanoa*.

*Pera* is a Neotropical taxon of the subfamily Acalyphoideae, with ca. 30 species distributed from Cuba and Central America to southern Brazil, and highest diversity in the Amazon (Webster 1994). It is the only member of the tribe Perea (Klotz. & Gcke.) Pax & K. Hoffmann, a position supported unanimously by many who have made treatment to the genus (Baillon 1858; Pax & Hoffmann 1919; Jablonski 1967; Webster 1994). It exhibits a unique morphological character among the Euphorbiaceae: the unisexual pseudanthia (cymose inflorescence), with reduced flowers involved by a showy involucre bract (yellow, cream, white or sometimes red), which is fragrant and more or less globose. The most recent studies were published by Gillespie & Ambruster (1997), comprising only 5 species from the Guianas, and by Webster *et al.* (1999), comprising 6 species included in the *Flora of Venezuelan Guiana*. In Brazil stands out the study by Leal (1951), who proposed some new species. Bigio (2009) made a taxonomic treatment of 13 species from the Brazilian Amazon. Recently, two new species were proposed: *P. manausensis* Bigio & Secco (Bigio & Secco 2010) and *P. eiteniorum* Bigio & Secco (Bigio & Secco 2011).

Molecular systematics led to great advancement in studies on Euphorbiaceae. However, morphological characteristics hinder the insertion of some genera in this family, as it is the case of *Pera*, which exhibits inflorescences inside an involucre bract, and its flowers and floral parts in the pseudanthia. By having this inflorescence type, *Pera* is similar to *Dalechampia*, though the latter belongs to Euphorbiaceae s.s.

*Micrandra* is an example of an Amazonian genus that needs revision. According to Webster (1994), it is composed of seven species, and belongs to Euphorbiaceae, subfamily Crotonoideae, tribe Micrandreae, subtribe Micrandrinae, together with *Cunuria* Baillon and *Micrandropsis* Rodrigues. According to APG system (APG III 2009), *Micrandra* would be subordinated to Euphorbiaceae s.s. The most recent study on this

genus remains Schultes (1952). Therefore, the genus needs revision, though Berry in Webster *et al.* (1999) provided a synopsis of its species in the Flora of the Venezuelan Guiana.

Schultes (1979) published additional notes on *Micrandra*, focusing the economic potential of the genus, especially as a source of latex for rubber production. It is important to revision this genus, especially because of the close relationship that it has with *Cunuria*, which, according to Baldwin & Schultes (1947), has 4 species and a variety distributed in the Amazon. However, Schultes (1952) considered them as synonyms of *Micrandra*, proposing thus new combinations. Webster (1994) drew attention to this fact, but kept *Cunuria* as a valid genus. The relationships between *Micrandra*, *Cunuria*, and *Micrandropsis*, the latter recently collected also in the state of Pará (it had been previously found only in the state of Amazonas), need to be better established.

According to Webster (1994), *Dalechampia* is a genus of Euphorbiaceae, subfamily Acalyphoideae, tribe Plukenetieae (Benth) Hutchinson, positioned isolatedly in the subtribe Dalechampineae, and it is composed of 100 species, out of which 90 are distributed in tropical America. In the APG system (APG II 2009), this genus is included in Euphorbiaceae s.s. It has an uncommon morphological characteristic to Euphorbiaceae, which is the specialized inflorescence of the type bilabiate, bisexual pseudanthia, with two involucre bracts, usually colorful, with separate staminate and pistillate flowers. This type of pseudanthia is different from that found in *Pera*. Webster & Armbruster (1991) recognized six sections for the 90 Neotropical species of the genus: *Dalechampia* section *Rhopalostylis* Pax & Hoffmann, *D.* section *Dioscoreifoliae* Pax & Hoffmann, *D.* section *Cremophyllum* (Scheidweiler) Baillon, *D.* section *Coriaceae* Pax & Hoffmann, *D.* section *Tiliifoliae* Webster & Armbruster, and *D.* section *Dalechampia*. According to the survey carried out in the herbaria MG and IAN, and based on Webster & Armbruster (1991), 17 species occur in the Brazilian Amazon; only *Dalechampia* section *Coriaceae* has probably no representatives in the region. Gillespie & Armbruster (1997) revised 18 species of *Dalechampia* for the Flora of the Guianas, providing only 4 illustrations, whereas Armbruster in Webster *et al.* (1999) revised briefly the 12 species of the Flora of the Venezuelan Guiana. In Brazil, the study by Rodrigues (2007) is the most up-to-date, and included four species of Distrito Federal.

The taxonomic treatment of *Dalechampia* by Webster & Armbruster (1991) is still the most up-to-date. These authors provided a detailed study on the morphology, described briefly the genus, sections and subsections, and two new species that they proposed. However they did not provide full descriptions and illustrations for other species of the genus and did not cite most collections examined, providing only the citation of the types. Therefore, Secco & Bigio (unpublished data) are revising and updating the species of Brazil, providing detailed keys, descriptions, and illustrations, since they were not yet subjected to complete taxonomic treatment.

Webster (1994) states that *Amanoa* belongs to Euphorbiaceae, subfamily Phyllanthoideae, tribe Amanoeae (Pax & Hoffmann) Webster, together with *Pentabrachion* Müll. Arg., a monotypic genus of western Africa. However, according to the APG system (APG III 2009), the taxon would be part of the family Phyllanthaceae.

Most of the 16 *Amanoa* species occur in the Neotropics (13); only three are endemic to Africa. The genus was never subjected to a complete revision; the most recent study is still the one carried out by Hayden (1990), which provided an identification key for the Neotropical species, described four new species, proposed a new name (*A. sinuosa* Hayden), and commented on *A. guianensis* Aublet, a type species and its varieties. The taxonomic treatment by Hayden (1990) needs update, especially because many samples available in the herbaria of the IAN, INPA, and MG were not analyzed and new collections were accomplished lately, making it necessary to make a new approach to the genus. Webster *et al.* (1999) updated only the species present in the Flora of the Venezuelan Guiana. Secco (2005) has made a treatment for two species for the Flora of the Ducke Reserve, Manaus, state of Amazonas, and Secco *et al.* (2010) provided an updated checklist of the species present in Brazil.

In the herbaria of MG and IAN, the most representative of eastern Amazon, there are many collections lacking updated identification of *Amanoa*; some contain only fruits or other not seen with entire reproductive parts, so new collections are needed. Besides, the complete material (with flowers and fruits) needs to be analyzed by a specialist, since many samples were identified by comparison, and not always by specialists. This hinders the recognition of some species with more restricted distribution in the Amazon, such as *Amanoa glaucophylla* Muell. Arg., *A. gracilima* W.J. Hayden, and *Amanoa neglecta* W.J. Hayden.

*Gymnanthes* Swartz does also need further studies. This genus has approximately 40 species, according to Webster (1994), and belongs to the subfamily Euphorbioideae, tribe Hippomaneae, subtribe Hippomaninae. According to the APG II system, the genus belongs to Euphorbiaceae *s.s.* and includes also *Actinostemon* Mart. ex Kl. Although the greatest specialists in Euphorbiaceae, such as Pax & K. Hoffman (1912), Baillon (1858) and Mueller (1866), have kept *Gymnanthes* and *Actinostemon* as separate genera, Webster & Huft (1988) and Webster (1994) synonymized *Actinostemon* with *Gymnanthes*, since the characters to separate it from *Gymnanthes* are not convincing from the taxonomic perspective. Despite that, Webster *et al.* (1999) considered *Actinostemon* as an independent genus, separated from *Gymnanthes*. Esser (1999), in a partial taxonomic treatment of the Hippomaneae of Malaysia, mentioned the inclusion of *Actinostemon* in *Gymnanthes* proposed by Webster (1994), but did not keep it as a synonym of *Gymnanthes*. Previously, authors such as Jablonski (1967, 1969) and Gillespie (1993) kept *Actinostemon* and *Gymnanthes* separated, though Jablonski (1967) stated that the distinction of the two genera based on the number of the stamens is very ambiguous. The taxonomic treatment proposed by Jablonski (1969) is still insufficient, as the author did not describe or illustrate all species, detailing more the two new species described (*Actinostemon unciiformis* Jabl., of Bahia, and *A. appendiculatus* Jabl., of northeastern, including Pernambuco, and southeastern Brazil, including Espirito Santo and probably Rio de Janeiro). Webster (pers. comm.) stated that he was inclined to reconsider *Actinostemon* as an autonomous genus, though he had included it in *Gymnanthes* (Webster 1994). He admits that *Actinostemon* is very close to *Gymnanthes*, and most representatives of Hippomaneae (ex. *Sebastiania* Sprengel, *Actinostemon*) have not been well delimited morphologically.

Studies by Melo (2006), revising *Sebastiania*, included some species of this genus in *Gymnanthes/Actinostemon*. According to this author, only the species of *Sebastiania* section *Sebastiania* should be included in *Sebastiania*.

The problems exposed above led to a study on species of *Gymnanthes* (and *Actinostemon*), emphasizing those found in the Amazon, as a contribution to the taxonomic delimitation of the aforementioned taxa, since both Webster (1994) and Esser (1999) admit that the generic delimitation of the Neotropical representatives of Hippomaneae is still under dispute.

## II. Euphorbiaceae in the Northeastern Region

Studies on Euphorbiaceae *s.l.* in northeastern Brazil focused mainly the floras of the states of Bahia and Pernambuco. The diversity of this family is still poorly known, though some relevant studies have been carried out, aiming at solving mainly problems in the tribes Euphorbieae, Hippomaneae, Hureae, and Crotonae, particularly in the genus *Croton*. In this aspect, a pioneer study by Bezerra & Fernandes (1982) stands out, which comprises six *Croton* species, locally known as ‘marmeleiros’, emphasizing the presence of *Croton sonderianus* Muell.Arg. as the most abundant in the region.

Studies comprising the entire family were carried out by Cordeiro (1995) for the Flora of Pico das Almas, Chapada Diamantina, and Carneiro *et al.* (2002) for the Euphorbiaceae of “Inselbergs of Milagres” (state of Bahia). For the whole northeastern region, Cordeiro & Carneiro-Torres (2006) listed 211 species and 45 genera in the plant checklist of northeastern Brazil. A comprehensive study on the family Euphorbiaceae for reserves in the Caatinga of Pernambuco was carried out by Lucena (2009), who studied 54 species. A synopsis of this family, comprising 25 species and 11 genera of Serra de Itabaiana National Park (state of Sergipe), was published by Lucena *et al.* (2009). Lucena & Alves (2010) added 29 Euphorbiaceae taxa, with comments, to the list of this family in the northeastern region.

Taxonomic treatments for genera and tribes were also carried out for Chapada Diamantina, located within Bahia and Pernambuco. Carneiro-Torres *et al.* (2003b) studied the genus *Phyllanthus* (currently Phyllanthaceae) reporting 11 species, and Carneiro-Torres *et al.* (2002) studied the tribe Euphorbieae and recognized 16 species. Still regarding *Phyllanthus*, Silva & Sales (2007), based on Silva (2004), found 17 species in the state of Pernambuco and 11 species in the Caatinga biome (Silva & Sales 2004). A synopsis of *Phyllanthus* with 36 species for northeastern Brazil was also published by Silva & Sales (2008). Silva (2009) described two new species of *Phyllanthus*. The study of *Cnidoscolus* Pohl for the state of Pernambuco was carried out by Melo & Sales (2008). Santos & Sales (2009) studied also the tribe Hippomaneae in the state of Pernambuco.

Revision and morphological phylogeny studies were carried out and other are in developmental phase focusing mainly the genera of the tribe Hippomaneae. The revision of *Sebastiania*, currently circumscribed to 19 species, was developed by Melo (2006). Studies

on morphological phylogeny of *Sebastiania*, including 17 species and 13 species of other Hippomaneae genera and the use of carpological characters in the delimitation of genera of the tribe Hippomaneae were developed by Souza (2011) and submitted for publication. Revisions and morphological and molecular phylogeny studies of *Gymnanthes* and *Stillingia* Garden ex L. are being carried out. For the tribe Hureae studies on morphological phylogeny and a synopsis of the species of this tribe have been carried out by Oliveira (2010), who analyzed 17 species of the genera *Algernonia* Baill. (11 species), *Hura* L. (1 species), and *Ophthalmoblapton* Allemão (4 species); *Tetraplandra* was considered as a subgenus of *Algernonia*.

The best studied Euphorbiaceae genus in northeastern Brazil is doubtless *Croton*, in particular in the semi-arid region. Local and regional floras and revisions of sections have been published. The revision of *Croton* section *Argyroglossum* in Brazil was carried out by Gomes (2006) and Gomes *et al.* (2010). A morphological phylogeny study on *Croton* section *Ocalia* is being concluded. Silva *et al.* (2009) studied 15 species of *Croton* of the micro-region of Vale do Ipanema, in the Caatinga biome, state of Pernambuco. In this state, Silva *et al.* (2010) published a synopsis of *Croton*, reporting 35 species of the genus. Attention should be given to *Croton* in the Caatinga biome, including the phytogeography of this genus, of which 68 species were recognized by Carneiro-Torres (2009). Lucena (2000) analyzed 14 species that occur in Zona do Litoral and Zona da Mata of Pernambuco. Still regarding *Croton*, a study on trichomes of species that occur in Pernambuco was carried out by Lucena & Sales (2006). Other studies are in the phase of data collection, standing out the studies of *Croton* in Chapada do Araripe, state of Ceará, and Vale do Catimbau National Park, Buique, state of Pernambuco, and the flora of the state of Rio Grande do Norte.

Recently, some new species have been described for northeastern Brazil. A new species of *Gymnanthes* was proposed by Esser *et al.* (2010). Gomes *et al.* (2010) described a new species of the genus *Croton*, and Carneiro-Torres *et al.* (2011) described three new species for this genus in the Caatinga.

Although Euphorbiaceae studies have advanced recently, there are still many groups that need to be studied. Among Hippomaneae, the genus *Sapium* P. Browne deserves attention for the difficulty of delimiting its species. The species of *Croton* that occur in forests and restingas still need to be further investigated.

### III. Euphorbiaceae in the Southeastern Region

#### IIIa. Research in São Paulo

In the case of the research group of the state of São Paulo, the most recent studies focused mainly Euphorbiaceae s.s. and Phyllanthaceae, comprising revisions, floras, and descriptions of new species.

**Floras:** The survey carried out in Cadeia do Espinhaço by Lima (2001) and Lima & Pirani (2003) reported 22 species: *Croton antisiphiliticus* Mart., *C. argyroglossum* Baill., *C. atrofusus* Muell. Arg., *C. buxifolius* Muell. Arg., *C. campestris* A. St.-Hil., *C. celtidifolius* Baill., *C. floribundus* Spreng., *C. glutinosus* Muell. Arg., *C. grewoides* Baill., *C. julopsidium* Baill., *C. lobatus* L., *C. lundianus* Muell. Arg., *C. migrans* Casar., *C. muscicarpa* Muell. Arg., *C. mysinites* Baill., *C. nummularius* Baill., *C. siderophyllus* Baill., *C. subferrugineus* Muell. Arg., *C. timandroides* Muell. Arg., *C. urucurana* Baill., *C. aff. desertorum* Muell. Arg., and *C. aff. petraeus* Muell. Arg.

The study on the tribe Crotonae in the state of São Paulo (Caruzo 2005; Caruzo & Cordeiro 2007) reported 37 *Croton* species and two *Astraea* Klotzsch species. Among the *Croton* species, several occur also in other countries, and some are broadly distributed all over the Neotropics, such as *C. glandulosus* L., *C. hirtus* L'Herit., *C. pedicellatus* Kunth, and *C. triquetus* Lam.; others are moderately distributed in South America: they occur in Bolivia, Paraguay, Argentina, Uruguay, and center-western, southeastern and southern Brazil, such as *C. urucurana* Baill., *C. didrichsenii* Webster, and *C. rottlerifolius* Baill.; in Argentina, Paraguay, and Brazil, such as *C. antisiphiliticus* Mart.; in Bolivia, Paraguay, center-western, southeastern and southern Brazil, such as *C. gracilipes* Baill.; in Paraguay and most part of Brazil, such as *C. floribundus* Spreng.; in Argentina, Uruguay, southeastern and southern Brazil, such as *C. lanatus* Lam.; in Bolivia, center-western, southeastern and southern Brazil, such as *C. grandivelus* Baill.; in Paraguay, center-western, southeastern and southern Brazil, such as *C. serratifolius* Baill.; in Argentina, southeastern and southern Brazil, such as *C. glechomifolius* Muell. Arg.; and in Bolivia, northeastern and southeastern Brazil, such as *C. tricolor* Klotzsch ex Baill. Among the species exclusively Brazilian are: *C. lundianus* (Dir.) Muell. Arg. which occurs all over Brazil; *C. piptocalyx* Muell. Arg., found in northeastern, center-western and southeastern Brazil; *C. macrobothrys* Baill., found in northeastern, southeastern and southern Brazil; *C. fuscescens* Spreng., *C. hemiargyreus*

Muell.Arg. and *C. sphaerogynus* Baill., present in northeastern and southeastern regions; *C. fuscus* (Didr.) Muell.Arg., *C. leptobotrys* Müll.Arg., *C. sancti-crucis* S. Moore and *C. sclerocalyx* (Didr.) Muell.Arg., in center-western and southeastern; *C. alchorneicarpus* Croizat, *C. ceanothifolius* Baill., *C. celtidifolius* Baill., *C. dichrous* Muell.Arg., *C. heterodoxus* Baill., *C. organensis* Baill., *C. salutaris* Baill., *C. serpyllifolius* Baill. and *C. vulnerarius* Baill., in southeastern and southern; *C. compressus* Lam. and *C. erythroxyloides* Baill., with distribution restricted to southeastern Brazil; and *C. priscus* Croizat endemic to the state of São Paulo.

Besides, a Rapid Color Guide, containing photos of the tree *Croton* species of the Atlantic Forest, was produced and distributed by the Field Museum of Natural History (Caruzo 2005).

The Flora of Grão Mogol, state of Minas Gerais (Cordeiro 2004), reported 15 genera and 38 species of Euphorbiaceae s.l.: *Acalypha* L. (1), *Alchornea* (1), *Bernardia* Houtstoun ex Miller (1), *Chamaesyce* S.F. Gray (2), *Croton* (11), *Dalechampia* (1), *Euphorbia* L. (2), *Mabea* (1), *Manihot* (1), *Maprounea* Aublet (1), *Pera* (1), *Phyllanthus* (5), *Richeria* (1), *Sebastiania* (7), and *Stillingia* (1).

Among ongoing flora studies are the one of the state of São Paulo, in which the family Euphorbiaceae s.s. is represented by 36 genera and ca. 139 species, as follows: *Acalypha* (14), *Actinostemon* (3), *Adelia* L. (1), *Alchornea* (3), *Algernonia* (1), *Aparisthium* (1), *Astraea* (2), *Bernardia* (3), *Caperonia* A.St.-Hil. (3), *Caryodendron* Karsten (1), *Chaetocarpus* Thwaites (1), *Chiroptalum* A. Jussieu (2), *Cnidoscolus* Pohl (2), *Croton* (37), *Dalechampia* (12), *Euphorbia* (17), *Jatropha* L. (2), *Joannesia* Vellozo (1), *Mabea* (2), *Manihot* (9), *Microstachys* A. Juss. (5), *Maprounea* (1), *Margaritaria* (1), *Micrandra* (1), *Pachystroma* Muell. Arg. (1), *Pausandra* Radlk. (1), *Pera* Mutis (2), *Philyra* Klotzsch (1), *Plukenetia* L. (1), *Ricinus* L. (1), *Romanoa* Trevisan (1), *Sapium* (2), *Sebastiania* (3), *Tetraplandra* Baillon (1), *Tetrorchidium* (1), and *Tragia* Plumier ex L. (6); and the *Phyllanthaceae* by 5 genera and 5 species: *Gonatogyne* Muell. Arg. (1), *Hieronyma* Fr. All. (1), *Margaritaria* (1), *Richeria* (1) and *Savia* McPherson (1). Among these genera, monographs on *Croton* and *Astraea* have already been prepared by Caruzo & Cordeiro (2007), whereas those on *Dalechampia*, *Plukenetia*, *Romanoa*, and *Tragia* are still in preparation (R. Secco, personal communication).

The monograph on the genus *Phyllanthus* (Phyllanthaceae), represented by 16 species in the state of São Paulo, has already been concluded (Martins & Lima 2011, in press).

**Reviews:** Among revisions of the genus is the study by Lima (2006) on *Croton* section *Lamprocroton* (Muell. Arg.) Pax. This section is entirely Neotropical, with an interesting disjoint distribution between South America and Mexico, and is characterized by the shrubby habit of its species, indumentum of lepidote trichomes, absence of cymules on the inflorescence, and bifid style branches (Lima & Pirani 2008). Twenty-six species were recognized in the section, among which three were new: *C. imbricatus* L.R. Lima & Pirani, *C. muellerianus* L.R. Lima & Pirani, and *C. pygmaeus* L.R. Lima & Pirani; the first endemic to the state of Bahia, the second to Paraná and the third endemic to Rio Grande do Sul. In addition to the taxonomic treatment and phylogenetic analysis of the section, morphological studies of leaf trichomes and pollen grains of some of its species have been also carried out.

Caruzo (2010) made another revision on *Croton* section *Cleodora* (Klotzsch) Baill. Caruzo *et al.* (2011) assessed the phylogenetic relationships of this section, using the nuclear region ITS and the plastidial regions *trnL-F* and *trnH-psbA*, separately and combined. In the individual phylogenies and in that with combined data, species of the section *Cleodora sensu* Webster (1993) emerged, almost in their totality, together with other species that had been originally not included in the section, forming a strongly supported clade characterized by two morphological synapomorphies: female flowers with imbricate sepals and style united at the base or above. *Croton* section *Cleodora* is an exclusively Neotropical section that has an interesting disjoint distribution among Central America, Amazon, and Atlantic Forest. Eighteen species were recognized for this section; three of which were new (Caruzo *et al.* 2008; Caruzo *et al.* 2010a,b). The section is composed of arboreal or shrubby species, usually latescent, covered by trichomes that are adpressed/star-shaped, star-shaped/lepidote, lepidote or more rarely star-shaped and multiradiate; the leaves exhibit a pair of acropetiole or basilaminar glands; inflorescences are terminal, rarely axillary, basal cymules, usually bisexual; male flowers are campanulate, rarely subcampanulate, valvate or slightly imbricate, with stamens between 15–25; female flowers are campanulate to urceolate, in general conspicuously imbricate, styles 4-fidus or multifidus, united at the base or above, usually forming a crown. In this new circumscription of the section *Cleodora*, two new subsections were recognized: *Sphaerogyni*, characterized by sepals with quincuncial estivation in its pistillate flowers, and *Spruceani*, characterized by sepals with imbricate or reduplicate-valvate estivation.



The revision of *Microstachys*, associated with a phylogeny of Hippomaneae, is in progress (I. Cordeiro, personal communication).

***Brasiliocroton* P.E. Berry & Cordeiro, a new genus, and the reestablishment of *Astraea*:** according to Berry *et al.* (2005a), the erect stamens on the flower bud of *Brasiliocroton mamoninha* P.E. Berry & Cordeiro are the main morphological characteristic that differentiates it from *Croton*. However, the best justification for the establishment of this new genus is its position as sister-group of most *Croton* species, with the exception of *Croton lobatus* L. and *C. praetervisus* Muell.Arg., which belong to *Croton* section *Astraea* (Klotzsch) Baill. In order to make *Croton* a monophyletic group, Berry *et al.* (2005b) incorporated into the taxon other small genera formally placed in the tribe Crotoneae and excluded from it species of the section *Astraea*, which was reestablished by the authors as the genus *Astraea* Klotzsch.

### IIIb. Research in Rio de Janeiro

In the state of Rio de Janeiro, research has been focused on Euphorbiaceae *s.l.* Studies started in the 1970s with the taxonomic revision of the genera *Algernonia* Baill. and *Tetraplandra* Baill. Following these studies, Emmerich (1981) proposed new species (*A. glaziouii* and *A. paulae*) and a new combination: *A. gibbosa* (Pax & K. Hoffm.) Emmerich. Oliveira (1985) studied *Sebastiania corniculata* (Vahl) Müll.Arg. (currently a synonym of *Microstachys corniculata* (Vahl) Griseb.).

In the 1980s, studies focused taxonomic problems at different infrageneric levels. The validity of infraspecific taxa, accepted at that time, was tested by several researchers. Senna-Valle (1983) showed that the infraspecific taxa of *Pachystroma ilicifolium* Müll. Arg. (currently *Pachystroma longifolium* (Nees) I.M.Johnst.) were no more than phenotypic expressions of characters, such as shape and leaf dimensions; these variations occur frequently in a single individual. These taxonomic studies were almost invariably associated with anatomical and palynological studies, which observed the presence of structures that could be used in the taxonomic characterization of the Euphorbiaceae, such as the presence of Rosanoff's crystals in *Actinostemon concolor* (Spreng.) Muell. Arg. (Emmerich & Senna-Valle 1983). In the same genus, Senna-Valle (1983, 1984, 1985) studied *A. communis* var. *spathulatus* (Muell. Arg.) Pax (currently *A. klotzschii* (Didr.) Pax), *A. verticillatus* (Klotzsch) Baill., and *A. concolor* (Spreng) Muell. Arg. – all present in the state of Rio

de Janeiro. Oliveira & Senna (1983) also studied leaf anatomy for the characterization of *Anabaenella tamnoides* (Juss.) Pax & Hoffm. In *Sebastiania* Spreng., Oliveira & Penna (1985) studied the taxa *S. brasiliensis* var. *erythroxyloides* (Muell.Arg.) Muell. Arg. (currently *Sebastiania brasiliensis* Spreng.), and *S. glandulosa* var. *fallax* (Müll.Arg.) Pax (currently *Microstachys corniculata* (Vahl) Griseb.), approaching their taxonomy and leaf anatomy. Palynological studies were associated with taxonomic studies on *Sebastiania* Spreng. (Gonçalves-Esteves *et al.* 1986). Oliveira & Sá-Haiad (1988) pointed out structural similarities and differences between *Euphorbia heterophylla* L. and *E. cyathophora* Murray. Emmerich (1987) devoted herself to the taxonomic study of *Mabea fistulifera* Mart. Oliveira *et al.* (1989) studied the Euphorbiaceae that occur in the restingas of the state of Rio de Janeiro from a floristic and taxonomic perspective.

In addition to those, stand out revisions of *Chaetocarpus* Sw. (Alves 1982) and taxonomic/floristic studies, such as those on *Alchornea* Sw. that occur in Rio de Janeiro (Silva 1993), *Dalechampia* Plum. (Maia *et al.* 2002), *Pera glabrata* (Penna 1981), and *Croton* L. (Sá-Haiad 1987). The latter was pioneering in Brazil regarding the use of scanning microscopy for studying Euphorbiaceae species. It is important to emphasize the multidisciplinary approach of these studies, in which leaf anatomy and pollen grains were used as subsidies for a better taxonomic revision of the species.

In the 1990s, studies focused the taxonomy of genera and species found in different Brazilian ecosystems, studying the morphology of taxa such as *Croton urticifolius* Lam., *Sebastiania bidentata* (Mart. & Zucc.) Pax (currently *Microstachys bidentata* (Mart. & Zucc.) Esser, following Oliveira & Ferraz (1991)), *Caryodendron grandifolium* (Muell.Arg.) Pax (currently *Caryodendron janeirensis* Muell. Arg., following Senna-Valle & Campos (1992)), and nomenclatural types in the family (Oliveira & Senna 1991). Silva (1993) studied varieties of *Alchornea triplinervia* (Spreng.) Muell.Arg., and only two out of the eight previously established varieties were accepted. In regional studies, Euphorbiaceae was recorded in florulas, such as the Flora of Mato Grosso, mainly through studies on species of *Sebastiania* Spreng. and *Sapium* P. Br (Oliveira 1991); the Flora of the Cairuçu Reserve - Parati, Rio de Janeiro; the Flora of the Restinga de Jurubatiba National Park - Rio de Janeiro (Oliveira *et al.* 1997); and the Flora of the Atlantic Forest of southeastern Brazil. With a multidisciplinary

approach, stand out the studies on the sexual system and pollination types of some Euphorbiaceae of sandy coastal plains (*restinga*) (Oliveira *et al.* 1989) and studies on *Capersonia*, *Chamaesyce* Gray, *Croton* L., *Euphorbia*, *Sebastiania* Spreng. and *Stillingia* Gard. Senna-Valle (1999) studied the complex *Sapium glandulatum* (Vell.) Pax (currently *Sapium glandulosum* (L.) Morong), assessing phytochemical, anatomic, palynological, pharmacological, and taxonomic aspects.

From the 2000s on, the number of monographs, dissertations, and theses that focused the family increased. Medeiros *et al.* (2002, 2007, 2009, 2011) devoted themselves to the taxonomic and morphological study of *Croton* species present in rocky fields of Minas Gerais. Initially, the study was restricted to the São José Mountain Range, Tiradentes, as part of the Flora of São José Mountain Range (Alves & Kolbek 2009). The species richness of *Croton* section *Medea* identified in this study led to the morphological and taxonomical study of the section, using specimens from southeastern Brazil. In these studies, the focus was the taxonomic validation of rare species, which were lacking in herborized collections. Some of these species were rediscovered (such as *Croton gnidiaceus* Baill., *C. josephinus* Muell.Arg. and *C. staechadis* Baill.), as they have been no longer collected since the type material was described. As a result from this approach and due to the high endemism in rocky fields, three new species were described for the section. The section could be recognized through a matrix of relevant morphological characters for its circumscription. Pinto (2004) studied the biological diversity of Euphorbiaceae in Serra da Tiririca State Park, Niterói, state of Rio de Janeiro, and recorded 21 genera and 41 species. Sá-Haiad *et al.* (2009) carried out studies aiming at contributing to the knowledge of relationships among *Croton*, *Brasiliocroton*, and *Astraea*. Morphological, anatomical, and palynological analyses were used to describe and compare species. The main objective of this study was to search for structural elements to be used in analyses of the lineage of crotonoids. Vegetative characteristics – both morphological and anatomical – as well as the presence of reduced petals on pistillate flowers – are similar among the studied specimens of *Croton* section *Cyclostigma* and *Brasiliocroton mamoninha*, differing from *Astraea*. The presence and protodermal origin of the idioblasts with lipophilic content and the interruption of the palisade by collenchyma layers on the adaxial side of the mid vein are common to the *Croton* L. species analysed

and *Brasiliocroton*. The type of inflorescence, as well as some morphological characters of its reproductive structures, distinguishes *B. mamoninha* from the other two genera. The average size of the pollen grains of the studied species of *Astraea* and *B. mamoninha* differs from that of representatives of *Croton* section *Cyclostigma*, which have large pollen grains. The presence of dorsiventrality, paracytic stomata, collateral vascular bundles, branched non-articulated laticifers and crystal idioblasts as well as spheroidal, unaperturate and with a croton-type ornamentation pattern pollen grains in the species studied indicates morphological similarities among the three genera. The interpretation of the stipite of the complex trichomes as emergences is a structural novelty for the group. The presence of innumerable characteristics associated with defense mechanisms, such as trichomes, idioblasts with crystal and/or with lipophilic content, laticifers and extrafloral nectaries, especially in the genus *Croton*, together with the possibility of both anemophilous and entomophilous pollination, may represent one of the explanations for its great success, which is manifested by a pantropical distribution and by the large number of species (Sá-Haiad *et al.* 2009). This group of researchers contributed with the study on Peraceae for the list of Brazil (Bigio *et al.* 2010). Currently, the group is devoted to the study of species of Euphorbiaceae *s.l.* present in the Flora of the State of Rio de Janeiro.

#### IV. Euphorbiaceae in the Southern Region

In the southern region, studies with a more general approach stand out: Smith & Downs (1959) made a preliminary assessment of the Euphorbiaceae of Santa Catarina; Rambo (1960) presented a list of 15 genera and 64 species of Euphorbiaceae in the state of Rio Grande do Sul, based on data of a private herbarium owned by the author; Klein (1977) provided morphological and ecological data of 27 *Croton* species in the state of Santa Catarina; Allem (1978) made a preliminary taxonomic assessment of ca. 40 *Croton* species in Rio Grande do Sul.

Allem (1979) proposed four new species and a section (*Calycireduplicatae* Allem) of *Croton* for Rio Grande do Sul. According to this author, these species would be represented by dioecious plants, what would be something extraordinary, since the *Croton* species known so far are all monoecious, usually with pistillate flowers on the base and staminate flowers on the rest of the rachis. However, in his descriptions, Allem (1979) states that the staminate and pistillate flowers are in separate inflorescences, but on the

same individuals, hence, those species would be, in fact, monoecious.

Probably, the greatest contribution to the taxonomic study of the Euphorbiaceae of southern Brazil was made by Smith *et al.* (1988), in a taxonomic treatment entitled Flora Illustrada Catarinense. These authors used the old subdivision of the family, approaching the subfamilies Phyllanthoideae (with two ovules in each locule of the ovary), in which stood out genera such as *Phyllanthus* and *Richeria*, among others, and Crotonoideae (with one ovule in each locule of the ovary), in which most genera were placed, such as *Acalypha*, *Croton*, *Euphorbia*, etc.

It was proven that studies on Euphorbiaceae *s.l.* are growing, particularly in the northern, northeastern, and southeastern regions of Brazil, with still some gaps in the central and southern regions. Research in these two last regions will lead to a broader knowledge of this important family.

There are many studies on Brazilian species of *Croton* L. However, species of the states of Mato Grosso, Goiás, part of the Brazilian Amazon (Pará, Amazonas, Amapá, and Roraima), Rio Grande do Sul, and Paraná, especially herbs, need revision.

There is a need for taxonomic revision/update also for *Phyllanthus*, *Dalechampia*, *Drypetes*, *Mabea*, and *Sapium* Jacq.; the latter is still a great challenge. In addition, we point out the need for more comprehensive taxonomic studies on the Brazilian Hippomaneae, in particular due to the changes in this taxon in the past few years, what lead to the establishment of novelties such as *Pseudosenefeldera* Esser, *Dendrothrix* Esser, *Rhodothyrsus* Esser, and *Pleradenophora* Esser.

We noticed a lack of published studies in Brazil on molecular systematics of the Euphorbiaceae *s.s.*, Phyllanthaceae, Picrodendraceae, and Putranjivaceae. We believe that graduate programs can provide the means to form new taxonomists and to choose modern methods for the taxonomic treatment of the genera that need additional studies, in order to define the species better. Special attention should be given to Peraceae, since this group is still being debated.

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