Euphorbia flaviana, a New Species from the Inselbergs of Bahia (Brazil) and Lectotypification of *E. crossadenia*

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Abstract—*Euphorbia flaviana*, a new species endemic to the State of Bahia in eastern Brazil, is described and illustrated. The new species belongs to *Euphorbia* [subgenus *Chamaesyce*] section *Crossadenia* and is morphologically most similar to *Euphorbia teres*, from which it differs in having thinner, longer, numerous verticillate branches, and involucre glands without appendages. An artificial key to all nine members of *Euphorbia* section *Crossadenia* is provided, and *Euphorbia crossadenia* is lectotypified.

Keywords—Euphorbiaceae, morphology, section *Crossadenia*, subgenus *Chamaesyce*.

Euphorbia L. (Euphorbiaceae) is one of the largest genera of flowering plants worldwide with about 2,000 species (Riina and Berry 2011). As part of the *Euphorbia* planetary biodiversity inventory project (Berry and Riina 2007; Esser et al. 2009), new *Euphorbia* species are being described from different parts of the world (Mayfield and Steinmann 2010; Pahlevani and Mozaffarian 2011; Carrillo-Reyes and Steinmann 2011). With 65 species in Brazil (Steinmann 2010), *Euphorbia* is the third most species-rich genus of Euphorbiaceae in the country after *Croton* L. (300 species), and *Manihot* Mill. (70 species) (Cordeiro et al. 2010). The Brazilian *Euphorbia* range in habit from annual herbs to small trees and perennial shrubs to subshrubs, some of them leafless (leaves are soon deciduous) and even cactiform species.

While conducting taxonomic studies in Neotropical *Euphorbia* we came across an undescribed leafless species from the state of Bahia. The Brazilian leafless species of *Euphorbia* (*E. appariciana* Rizz., *E. attastoma* Rizz., *E. estevesii* N. F. A. Zimmermann & P. J. Braun, *E. gymnoclada* Boiss., *E. holochlorina* Rizz., *E. phosphorea* Mart., *E. sipolisii* N. R. Brown, and *E. teres* M. Machado & Hofacker) grow on a wide range of substrates (limestone, sandstone, quartzitic and granitic outcrops, usually on sandy soils) and vegetation (dry forests, caatinga, grasslands, cerrados, campos rupestres, and open vegetation of coastal dunes) (Rizzini 1989). The new species differs from all the other Brazilian leafless species mainly by the presence of numerous verticillate branches, making the habit of this species similar to the growth form of an *Equisetum* species (Figs. 1, 2).

TAXONOMIC TREATMENT

Euphorbia flaviana Carn.-Torres & Cordeiro, sp. nov.—
 TYPE: BRAZIL. Bahia: Município de Milagres, Morro Pé de Serra, 25 Oct 1997, F. França, E. de Melo, C. Correia, P.P. Oliveira & B.M. da Silva 2413 (holotype: HUEFS; isotypes: SPF!, UFRPE!).

Differt ab *Euphorbia teres* M. Machado & Hofacker ramibus tenuioribus, equisetiformibus, usque ad 1.5 m longis, cyathis appendices destituti.

Leafless shrubs, 80–150 cm high, latex white. Stems terete, pencil-like, branches erect arranged in whorls, mature branches 6–14 verticillate; young branches green, apical part of branches reddish, old branches grayish-brown, glabrous; leaves rudimentary, lanceolate, 2.0–2.5 × 1.0–1.5 mm, soon deciduous; stipules inconspicuous. Cyathia solitary to geminate, terminal, sessile to subsessile; cyathophylls opposite, scale-like, lanceolate, 1.0–1.5 × 0.8–1.0 mm, apex acute, fimbriate along the margin near the base and at the apex; involucre turbinate, 1.5–2.2 × 2.0–2.5 mm, actinomorphic, glabrescent; involucre lobes triangular, greenish-yellow, with ciliate margin; involucre glands 5, elliptic, 0.8–1.0 mm long, greenish-yellow, without appendages. Staminate flowers ca. 20, 0.5–0.8 mm long, arranged in 5 cincinni; pedicel 1.5–2.0 mm long, bracteoles lanceolate, ciliate; anther dorsifixed, extrorse, transversely dehiscent. Pistillate flower 1, 2.0–2.5 mm long; pedicel ca. 1.0 mm long; ovary globose, 1.0–1.5 × 1.0–1.5 mm, glabrous; styles 3, bifid, revolute, 0.5–1.0 mm long. Fruit a schizocarp, 3-lobed, 3.0 × 4.5 mm, erect, glabrous, red; pedicel 3.0–4.0 mm long; seeds dark brown, ovoid, 2.6 × 2.0 mm, testa shallowly tuberculate, covered by a crustaceous, hydrophylic layer, becoming mucilaginous in water; ecarunculate. Figures 1, 2.

Additional Specimens Examined—BRAZIL. Bahia: Itatim, Morro das Tocas, 12°42'S, 39°46'W, Alt. 280–420 m, encosta rochosa do Inselberg, 20/IV/1996, (fl., fr.), F. França et al. 1601 (HUEFS, SP); 12°43'47"S, 39°43'27"W, 08/IV/2000, (fl.), I. Cordeiro et al. 2203 (HUEFS, RB, SP, SPF); ápice do Inselberg, 28/VII/2011, (fl.), D. S. Carneiro-Torres & F. França 1005 (HUEFS); Jacobina, Serra da Jacobina, Toca da Areia, 11°09'09"S, 40°30'16"W, Alt. 932 m, campo rupestre, 05/VII/1996, (fl.), H. P. Batista et al. PCD 3416 (ALCB, SP, SPF), 11°09'15"S, 40°48'33"W, Alt. 960 m, floresta estacional, solo arenoso, 31/III/1996, (fr.), M. L. Guedes et al. PCD 2723 (ALCB, SP, SPF); Milagres, Morro Pé de Serra, 12°52'S, 39°49'W, Alt. 510 m, encosta rocha exposta, 15/III/1997, (fl., fr.), F. França et al. 2151 (HUEFS, SP); Santa Teresinha, Morro do Cruzeiro, 12°48'S, 39°32'W, Alt. 288 m, encosta com rocha exposta, 13/IX/1997, (fl., fr.), E. B. Miranda et al. 04 (HUEFS); 20/XII/2002, (fl.), C. van den Berg et al. 927 (HUEFS).

Distribution and Habitat—*Euphorbia flaviana* is endemic to the montane region of Itatim, Jacobina, Milagres, and Santa Teresinha in the State of Bahia (Brazil) (Fig. 3). It grows on exposed rocky granitic outcrops or inselbergs, in campos

FIG. 1. *Euphorbia flaviana* (F. França et al. 2413, HUEFS). A. Habit. B. Cyathium with cyathophylls. C. Cyathophyll. D. Cyathium. E. Opened involucre. F. Involucral gland. G. Pistillate flower. H. Staminate flower. I. Cyathium with fruit. J. Seed, ventral view. K. Seed, dorsal view.

FIG. 2. A-C. *Euphorbia flaviana*. A. Habit. B. Detail of verticillate branches. C. Cyathia with involucre glands without appendages. D-E. *Euphorbia teres*. D. Habit. E. Cyathia showing the involucre glands with short white appendages. F-H. *Euphorbia gymnoclada*. F. Individual growing on deep white sand. G. Fertile branches with green cyathophylls and cyathia in different stages of development; the central cyathium with a well developed ovary. H. Cyathium with young fruit showing the digitate white appendages of the involucre glands. (Photos by D.S. Carneiro-Torres, M. Machado, and R. Riina).

rupestres vegetation or dry forests on sandy soil at 250–1,000 m elevation.

Conservation Status—According to IUCN criteria (IUCN 2001), the species is endangered EN B2ab(ii). *Euphorbia flaviana* has an area of occurrence less than 500 km² and it is only

known from four localities. In addition, the species is collected and used by the local people for ornamental purposes.

Etymology—The name of the species honors the Brazilian botanist Flavio França from Bahia, who made one of the first collections of the species in 1996.

FIG. 3. Map of the state of Bahia (Brazil) showing the distribution of *Euphorbia flaviana* with solid circles.

Euphorbia flaviana is different from the other leafless Brazilian *Euphorbia* species (*E. apparicioniana*, *E. attastoma*, *E. estevesii*, *E. holochlorina*, *E. gymnoclada*, *E. phosphorea*, *E. sipolisii*, and *E. teres*) in having an Equisetum-like verticillate branching pattern, involucre glands without appendages, and bifid, revolute styles. Phylogenetic analyses of ITS sequences place

Euphorbia flaviana (included as “*E. sp. nov. 1*” in Steinmann and Porter 2002) within *E. sect. Crossadenia* Boiss., a morphologically diverse group including perennial herbs, subshrubs, leafless, and pencil-stem plants (Figs. 2, 4). Additional analyses using *ndhF* sequences and a broader taxon sampling of the section confirm the phylogenetic placement of *E. flaviana* (Yang et al. in press). Based on their molecular phylogenetic results, which are also supported by morphological characters, Yang et al. (in press) are proposing two subsections within *sect. Crossadenia*. Morphological differences between *E. flaviana* and the other leafless species in *sect. Crossadenia* are listed and illustrated (Table 1; Fig. 2, 4), and the key below separates *E. flaviana* from all species in the section.

Rizzini (1989) considered *E. apparicioniana*, *E. attastoma*, *E. gymnoclada*, *E. holochlorina*, *E. phosphorea*, and *E. sipolisii* as succulent plants with aquiferous stems. This is probably true for all but two species in his list, *E. gymnoclada* and *E. apparicioniana*. The former species has narrow pencil-like branches similar to those of *E. flaviana*, which we do not categorize as succulent. *E. apparicioniana* could perhaps be considered scarcely succulent given its cactus-like ribbed stems. From our field observations, the narrow pencil-stem species (*E. gymnoclada*, *E. teres*, and *E. flaviana*) produce little latex when branches are cut whereas the cactus-like species with thicker stems mentioned by Rizzini (1989) (e.g. *E. phosphorea* and *E. attastoma*) produce copious latex from cut branches. Detailed anatomical studies are needed to detect the presence of specialized water storage tissue in the narrow pencil-stem species as well as in *E. apparicioniana* to either confirm their lack of specialized succulent tissue or determine their level of succulency.

ARTIFICIAL KEY TO SPECIES OF *EUPHORBIA* SECTION *CROSSADENIA* BOISS

1. Stem leaves rudimentary, soon deciduous; involucre glands 5 2
2. Involucre gland appendages 3–5-lobed, up 1 mm long; styles entire *E. gymnoclada*
2. Involucre gland appendages lacking or if present less than 0.2 mm long and irregularly dentate; styles bifid 3
3. Involucre gland appendages lacking, mature branches 6–14-verticillate *E. flaviana*
3. Involucre gland appendages irregularly dentate, mature branches dichotomous or 3(4)-verticillate 4
4. Stems terete, longest internodes ca. 10 cm long *E. teres*
4. Stems costate, longest internodes less than 5 cm long *E. apparicioniana*
1. Stem leaves well developed, persistent; involucre glands 4 5
5. Stems fleshy, thick, up 5 mm in diameter 6
6. Stems glabrous; leaves spirally arranged along branches; occurring in Bahia, Minas Gerais, and Pernambuco *E. sarcodes* Boiss.
6. Stems pubescent, leaves congested on the apex of branches (internodes obscured); endemic from Piauí *E. lycioides* Boiss.
5. Stems subwoody, slender, less than 3 mm in diameter 7
7. Stem and branches glabrous, cyathophylls orbiculate-acuminate, involucre gland appendages 4–7 digitate *E. goyazensis* Boiss.
7. Stem and branches pubescent, cyathophylls wide elliptical to linear, involucre gland appendages 8–15 digitate 8
8. Leaves linear, revolute, glabrous *E. crossadenia* Pax ex K. Hoffm.
8. Leaves elliptic, flat, pubescent *E. sessilifolia* Klotzsch ex Boiss.

Euphorbia crossadenia Pax ex K. Hoffm.—TYPE: BRAZIL. Bahia: Serra Masalina, 1914, *Lützelburg* 87 (lectotype: M, here designated).

Two syntypes, *Lützelburg* 87 and 262, are cited in the original protologue of *E. crossadenia*. Both specimens are held at M and they bear the original Pax annotation labels. We selected *Lützelburg* 87 at M as the lectotype because it includes a better representation of *E. crossadenia* with three entire flowering branches. The *Lützelburg* 262 sheet

includes several small fragments of stems and flowering branches.

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FIG. 4. A-B. *Euphorbia appariciana*. A. Habit of plant growing on rocky outcrops. B. Branch with cyathia. C. *Euphorbia crossadenia*. C. Photo of a branch with cyathia taken from a herbarium specimen (Graças *et al.* 886, SP). D-E. *Euphorbia goyazensis* Boiss. D. Habit. E. Cyathium with the two green cyathophylls underneath. F-G. *Euphorbia lycioides*. F. Habit of plant growing on white sandy substrate. G. Detail of branch with cyathia. H-I. *Euphorbia sarcodes* Boiss. H. Habit of plant growing on white sand. I. Cyathium with developed fruit. J-L. *Euphorbia sessilifolia* Klotzsch & Boiss. J. Habit. K. Young cyathium with early developing ovary. L. Involucral glands and appendages turn red as the cyathium matures; notice the hairy ovary. (Photos by D. S. Carneiro-Torres, M. B. R. Caruzo, A. S. F. Castro, M. Machado, and R. Riina).

TABLE 1. Main differences between the four Brazilian leafless species of *E. sect. Crossadenia* Boiss.

Species	Substrate	Habit	Mature branches	Gland appendages	Styles
<i>E. flaviana</i>	Granitic outcrops, sandy soils	Shrub, 80–150 cm	Terete, 6–14-verticillate	Absent	Bifid, revolute
<i>E. gymnoclada</i>	Coastal dunes, sandy soils	Herbaceous, 30 cm	Terete, dichotomous to 3-verticillate	3–5-lobed	Entire, erect
<i>E. teres</i>	Sandstone outcrops, sandy soils	Subshrub, 50 cm	Terete, dichotomous to 3-(4) verticillate	Irregularly dentate	Bifid, patent
<i>E. appariciona</i>	Sandstone outcrops, sandy soils	Herbaceous, 30 cm	Costate, dichotomous to 3-(8) verticillate	Irregularly dentate	Bifid, patent

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