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Original Paper

Cuphea (Lythraceae) in the state of Rio Grande do Sul, Brazil

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Abstract

The present work aims to provide a discussed floristic treatment for *Cuphea* (Lythraceae) from the Rio Grande do Sul state, Brazil. Morphological, ecological and geographic distribution data were obtained through the revision of several herbaria and from collection expeditions. A morphological analysis of the seeds under scanning electron microscopy and a preliminary assessment of the conservation status of the species were included. As a result, 12 native species and one variety were recorded for Rio Grande do Sul, often found in wet to dry grasslands of the Pampa biome. *Cuphea campylocentra*, *C. linifolia* and *C. lysimachioides* were preliminarily classified as threatened according to the categories and criteria of IUCN, joining *C. confertiflora*, which was officially cited in the List of threatened flora in Rio Grande do Sul. This study provides an identification key, illustrations, maps, morphological descriptions, and comments on the ecology, taxonomy, and geographic distribution of the *Cuphea* species in Rio Grande do Sul state.

Key words: Pampa, seed morphology, Southern Brazil, taxonomy, threatened species.

Resumo

O presente trabalho visa fornecer um tratamento florístico discutido para *Cuphea* (Lythraceae) do estado do Rio Grande do Sul, Brasil. Os dados morfológicos, ecológicos e de distribuição geográfica foram obtidos através da revisão herbários e a partir de expedições de coleta. Foram incluídas uma análise morfológica das sementes em microscopia eletrônica de varredura e uma avaliação preliminar quanto ao *status* de conservação das espécies. Como resultado, foram registradas 12 espécies nativas e uma variedade para o Rio Grande do Sul, frequentemente encontradas em campos úmidos a secos do bioma Pampa. *Cuphea campylocentra*, *C. linifolia* e *C. lysimachioides* foram classificadas preliminarmente como ameaçadas de acordo com as categorias e critérios da IUCN, juntando-se à *C. confertiflora*, que foi oficialmente citada na Lista da flora ameaçada no Rio Grande do Sul. Este estudo fornece uma chave de identificação, ilustrações, mapas, descrições morfológicas, e comentários sobre a ecologia, taxonomia e distribuição geográfica das espécies de *Cuphea* no estado do Rio Grande do Sul.

Palavras-chave: Pampa, morfologia das sementes, Sul do Brasil, taxonomia, espécies ameaçadas.

Introduction

Cuphea P.Browne is the largest genus of Lythraceae, comprising approximately 250 herbaceous and shrub species mainly found in open, wet or rocky habitats, in tropical and temperate Americas (Cavalcanti & Graham 2002; Graham *et al.* 2006; Graham & Graham 2014). The species of the genus are distributed in two main centers of diversification: a primary center in eastern Brazil (Espinhaço mountain range), and a secondary center in western and southern Mexico (Graham *et al.* 2006). In Brazil, there are 108 species of *Cuphea* (70 endemic), which grow mainly in campos rupestres and cerrado *sensu stricto* in the states of Bahia, Goiás and Minas Gerais (Graham & Cavalcanti 2013; Cavalcanti *et al.* 2022b).

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Cuphea is recognized by the zygomorphic flowers, elongated and spurred floral tube, ovary with a dorsal nectariferous gland at the base and by the exclusive mechanism of fruit dehiscence (Graham *et al.* 2006; Graham & Graham 2014). In the bilocular capsule, the dorsal locule splits along a single dorsal longitudinal line, and a complimentary longitudinal split occurs on the persistent floral tube (Graham & Graham 2014). The placenta then emerges through the slits by means of an increase in turgor pressure of cells, bearing nearly mature seeds (Graham & Graham 2014).

As established by Koehne (1874, 1877, 1903) and with changes and additions by later studies (Lourteig 1986; Graham 1988, 2017, 2019), *Cuphea* is divided into two subgenera and 13 sections. The main characters that Koehne (1874, 1877, 1903) used to separate the sections were the position of the pedicels, size of the floral tube, position of the nectary, position of the stamens, number of ovules, and the morphology of the seeds.

Phylogenetic studies based on molecular data (Graham *et al.* 2006; Barber *et al.* 2010) have revealed that the infrageneric classification of *Cuphea* is artificial, with no proposal for a new classification, and confirmed the monophyly of the genus in all analyses employed and *Pleurophora* D.Don as sister to *Cuphea*. Barber *et al.* (2010) recover a basal divergence event that supporting the two subgenera of Koehne's (1874, 1877, 1903) classification. Recent morphological and molecular analyses of specimens collected in mountains of eastern Brazil resulted in the description of a new genus of Lythraceae, *Gyrosphragma* T.B.Cavalc. & M.G.Facco, which is sister to *Cuphea* (Cavalcanti *et al.* 2022a).

To date, Koehne's (1903) monograph is the only study that completely addresses the genus. Since the 1980s, several sectional revisions have been conducted (*e.g.*, Lourteig 1986; Graham 1988, 2017, 2019; Graham & Cavalcanti 2013). In parallel, several regional studies involving *Cuphea* have been developed in Brazil (*e.g.*, Lourteig 1969; Cavalcanti 1990, 2004; Cavalcanti *et al.* 2001, 2016; Cavalcanti & Graham 2002, 2011). Both the revisions and the regional studies supply the "Flora do Brasil 2020" project (currently "Flora e Funga do Brasil") (Cavalcanti *et al.* 2022b) and are part of the collaborative work to build a new monograph of the genus that incorporates morphological and molecular information, and that will substantially modify the infrageneric classification of *Cuphea*.

Despite the importance of the genus in several aspects, floristic and taxonomic studies on *Cuphea* have not yet been carried out in the state of Rio Grande do Sul. Thus, the present work aims to provide updated knowledge about the genus *Cuphea* for that state, providing means for the identification of species, through an identification key, morphological descriptions, taxonomic comments with images, besides distribution maps and assessment of conservation status.

Material and Methods

The state of Rio Grande do Sul is located in the extreme south of Brazil, with its farthest coordinates between latitudes 27°05'S and 33°45'S and longitudes 49°41'W and 57°38'W, comprising an area of approximately 280,000 km² (Boldrini 2009). The climate varies from subtropical humid with hot summers (Cfa, according to Köppen's classification) to subtropical humid with mild summers (Cfb) (Alvares *et al.* 2013). Part of the state is included in the Atlantic Rainforest biome and part in the Pampa biome (IBGE 2004). It is important to highlight that the different grassland typologies of the two biomes cover most of Rio Grande do Sul state (62.2%) (Cordeiro & Hasenack 2009). In this study, the grassland ecological systems delimited by Hasenack (2017) and the classification of forest phytoecological regions according to IBGE (2012) were considered for the characterization of vegetation.

Morphological, ecological and geographic distribution data of native *Cuphea* species were obtained during expeditions in all regions of Rio Grande do Sul, and from specimens loaned from 17 herbaria (CNPO, CTES, FLOR, FURB, HAS, HBR, HPBR, HUCS, HURG, ICN, MBM, MPUC, PACA, PEL, RSPF, SI and SMDB; acronyms according to Thiers, continuously updated), including the entire collection of the genus for the state. The specimens collected in the field were deposited in the ICN herbarium. In total, 1,641 specimens were analyzed, from which the most representative materials were selected for inclusion in this study.

Morphological analyses were performed under a Leica M80 stereomicroscope. Seed morphology was described using light microscopy and scanning electron microscopy (SEM), employing a JEOL JSM6360 SEM. For SEM analysis, the dried seeds were fixed on a double-sided tape on specific supports and metallized with pure gold (Graham & Graham 2014). To verify the existence of starch storage in the roots of *Cuphea*

campylocentra Griseb., cross-sections of these structures were dipped in Lugol's staining solution (Johansen 1940) and then observed under a Leica light microscope DM300.

For species identification, specimens were compared with the descriptions of the protologues accessed through the Biodiversity Heritage Library (2022), and with images of the type materials available in databases at JSTOR Global Plants (2022), speciesLink (2022), and Reflora Virtual Herbarium (2022). The main works used for identification were by Koehne (1877, 1903), Lourteig (1969), and Cavalcanti & Graham (2002). The descriptive terminology is mostly in agreement with Stearn (1983) and Beentje (2010). The indumentum was described in part based on the work of Amarasinghe *et al.* (1991). For inflorescences, the terminology of Weberling (1989) and Endress (2010) was followed. The generic description was prepared with the information collected from the species of Rio Grande do Sul state.

The distribution maps were prepared based on the original or estimated geographic coordinates from the analyzed specimens from all herbaria and were produced in QGIS (2022). When absent, coordinates were estimated from the locality described on the label or by the centroid of the municipality using the speciesLink (2022) tools. The vector layer of grassland and forest ecological systems was adapted from Hasenack *et al.* (2010). The layer with the limits of the state of Rio Grande do Sul is from IBGE (2021).

Cuphea species occurring in the state of Rio Grande do Sul were included in the reassessment of the List of threatened flora with extinction in Rio Grande do Sul, published in a State Decree (No. 52.109, December 1, 2014). Only *C. confertiflora* A.St.-Hil. was categorized as threatened. However, due to the current weakening of Brazilian environmental policies associated with the increasing suppression of native flora (Mapbiomas 2021a, 2021b), a preliminary reassessment regarding conservation status was performed in this study, according to the guidelines for using the IUCN Red List Categories and Criteria (2012, 2019), based on criterion B. Estimates of the area of occupancy (AOO) and extent of occurrence (EOO), limited to the state of Rio Grande do Sul, were generated in GeoCAT (Bachman *et al.* 2011).

Photographs of species in their habitat and important morphological characters are provided in Figs. 1-5, and SEM photomicrographs of seeds in Figs. 6-8. Distribution maps appear in Figs. 9-11.

Results and Discussion

For the state of Rio Grande do Sul, 12 native species and one variety of *Cuphea* were registered. According to the infrageneric classification proposed by Koehne (1874, 1877, 1903), the species are classified in: *C.* subg. *Cuphea*, *C.* sect. *Cuphea* (*C. lindmaniana* Koehne *ex* Bacig. and *C. racemosa* (L.f.) Spreng.); *C.* subg. *Bracteolatae* S.A.Graham, *C.* sect. *Brachyandra* Koehne (*C. calophylla* var. *mesostemon* (Koehne) S.A.Graham and *C. carthagenensis* (Jacq.) J.F.Macbr.), and *C.* sect. *Euandra* Koehne (*C. campylocentra* Griseb., *C. confertiflora* A.St.-Hil., *C. glutinosa* Cham. & Schltdl., *C. linarioides* Cham. & Schltdl., *C. linifolia* (A.St.-Hil.) Koehne, *C. lysimachioides* Cham. & Schltdl., *C. tuberosa* Cham. & Schltdl., and *C. urbaniana* Koehne). Definitions of the subgenera and sections can be found in Koehne (1903) and Graham *et al.* (2006).

In Rio Grande do Sul, *Cuphea* species can be differentiated by a series of morphological characters, the main ones being described below. The xylopodium, a perennial woody underground structure of great gemiferous potential (Appezzato-da-Glória 2003), is present in *C. confertiflora*, *C. lysimachioides* and *C. tuberosa*, as observed by Graham & Cavalcanti (2013), and defines *C.* sect. *Euandra* subsect. *Oidemation* Koehne (Koehne 1903). This study reports the presence of tuberous roots in *C. campylocentra* (Fig. 5), never described for this species. The xylopodium confers resistance to seasonal fires in cerrados (Rizzini 1965; Appezzato-da-Glória *et al.* 2008) and grasslands of southern Brazil (Fidelis *et al.* 2009), which is also related to tuberous roots (Fidelis *et al.* 2009).

Bracteoles occur in pairs on the flower pedicels (which defines *Cuphea* subg. *Bracteolatae*; Koehne 1903; Graham 1988) in ten species, and are absent in *C. lindmaniana* and *C. racemosa* (which defines *C.* subg. *Cuphea*; Koehne 1903; Graham 1988). In the latter species, the flowers are oppositely inserted on the inflorescence axis (Figs. 3a; 4b), in the others the flowers are alternate or verticillate. The spur, a well-developed or undeveloped projection at the base of the floral tube that holds the nectar produced by a nectary (Graham 1998a), is described here by its shape: acute, obtuse, or truncate; and by its orientation: horizontal, ascending, or deflexed. *Cuphea linarioides* and *C. linifolia* stand out for having acute and ascending spurs (Figs. 2k; 3g). In the remaining species, the spurs are generally obtuse, horizontal to deflexed, rarely acute or truncate.

The position of the 11 stamens within the floral tube separates *Cuphea* species occurring in Rio Grande do Sul into the following groups: filaments free in the middle third of the floral tube, deeply included (which defines *C*. sect. *Brachyandra*; Koehne 1903), in *C. calophylla* var. *mesostemon* and *C. carthagenensis*; filaments free in the upper third of the tube, exserted to subexserted (which defines *C*. sect. *Euandra*; Koehne 1903), in the other species. Stamens with filaments deeply inserted in the floral tube are related to the autogamous mode of reproduction (Graham 1998b). Vesicles may be present on the inner surface of the floral tube, just below the insertion of the stamens, in the intercostal areas (Graham & Cavalcanti 2013). These are thin, membranous, blister-like patches of unknown function (Graham & Cavalcanti 2013). In this study, vesicles were confirmed in *C. campylocentra* (Fig. 1h), *C. carthagenensis* (Fig. 1m) and *C. urbaniana* (Fig. 4m), as already pointed out by Lourteig (1969) and Graham (2017).

Seed morphology proved to be useful in the identification of *Cuphea* species in Rio Grande do Sul. Among the diagnostic characters, *C. lindmaniana* and *C. racemosa* have the smallest seeds, 0.7–1.1 × 0.5–1 mm, being a frequent characteristic in *C*. sect. *Cuphea*, of which both are part (Graham *et al.* 1981). The largest seeds, 2.2–3 × 2.1–2.9 mm, were observed in *C. lysimachioides*. Only in *C. lysimachioides* and *C. campylocentra* is the apex usually emarginate (Figs. 6d; 8a), and a caruncle is exclusively present in *C. urbaniana* Koehne (Fig. 8k). Graham & Graham (2014) provide a SEM image of the seed of *C. urbaniana*, but do not comment on the caruncle, and there are no reports in the literature on the function of this structure in this species. Surface ornamentation was distinct in *C. campylocentra* (colliculate surface; Fig. 6f), and in *C. lindmaniana* and *C. racemosa* (rugose and foveolate surface; Figs. 7i; 8g). Graham & Graham (2014) describe the surface of *C. racemosa* in a similar way to what is reported here. Other morphological characters of the seeds are present in the species descriptions and comments.

From the 12 *Cuphea* species registered for the state, six present the northern limit of distribution in the states of Paraná or Mato Grosso do Sul (*C. campylocentra*, *C. confertiflora*, *C. lindmaniana*, *C. lysimachioides*, *C. tuberosa* and *C. urbaniana*; Cavalcanti *et al.* 2022b). However, no species is endemic to Rio Grande do Sul. *Cuphea confertiflora* is considered a rare species in this state, since it is known only from two historical collections. *Cuphea campylocentra*, *C. linifolia* and *C. lysimachioides* present populations with few individuals, as observed in the collection expeditions. *Cuphea carthagenensis*, *C. glutinosa* and *C. racemosa* are the most widely distributed species in Rio Grande do Sul (Figs. 9b; 10a; 11a). Only *C. confertiflora* and *C. linifolia* occur exclusively in the Atlantic Rainforest. The other ten species occur in both the Pampa and the Atlantic Rainforest biomes.

Representatives of the genus are herbs and subshrubs found in all grassland ecological systems, but with a greater presence in the Andropogoneae and Composite mixed grassland and Barba-de-bode grassland, in the Pampa biome, and in the Highland grassland, in the Atlantic Rainforest. They are rare in forest formations, with more records in Araucaria forest. The species grow commonly in wet grasslands, swamps, grasslands with rocky outcrops, riverbanks, forest edges and, sometimes, in anthropized areas, between 5–1,200 m above sea level. *Cuphea calophylla* and *C. carthagenensis* are ruderal plants, frequent in garden lawns, disturbed places, and pastures, and considered as weeds (Kissmann & Groth 2000; Cavalcanti & Graham 2002; Lorenzi & Matos 2002). Flowering and fruiting more predominantly from January to May and October to December, with the fertile phase generally absent in winter.

Regarding to preliminary assessments of the conservation status of the *Cuphea* species in the state of Rio Grande do Sul, *C. campylocentra* and *C. lysimachioides* were categorized as "Vulnerable (VU)", and *C. linifolia* as "Endangered (EN)". In the List of threatened flora with extinction in Rio Grande do Sul, published in a State Decree in 2014 (No. 52.109, December 1, 2014), *C. confertiflora* was categorized as "Critically Endangered (CR)", and that assessment was corroborated here. In the Red Book of the Flora of Brazil (Cavalcanti *et al.* 2013), nine *Cuphea* species were categorized as threatened, mainly distributed in the campos rupestres of the eastern and central-western mountains of the country. Of the total area of Rio Grande do Sul, about 31.38% still has natural or semi-natural coverage (Cordeiro & Hasenack 2009). In the Pampa biome, the native biodiverse vegetation, with about 2,150 grassland species (Boldrini *et al.* 2015), is being replaced by grain monocultures and silviculture (Veldman *et al.*

2015; Hasenack *et al*. 2019). According to the List of flora threatened with extinction in Rio Grande do Sul, 804 species were classified as threatened in different risk categories.

The occurrences of *Cuphea ingrata* Cham. & Schltdl., cited for the state of Rio Grande do Sul by Cavalcanti & Graham (2002) and Rodas & Briones (2010), *C. melvilla* Lindl., cited by Lourteig (1969) and Rodas & Briones (2010), *C. spermacoce* A.St.-Hil., cited by Lourteig (1969), and *C. thymoides* Cham. & Schltdl., cited by Lourteig (1969), were not confirmed and are in agreement with Cavalcanti *et al*. (2022b). *Cuphea fruticosa* Spreng., is cited for the state of Rio Grande do Sul by Cavalcanti & Graham (2002) and Rodas & Briones (2010). Graham *et al*. (2014) considers it as a synonym of *C. racemosa*. According to Cavalcanti & Graham (2002), *C. fruticosa* is identified by the presence of narrowly ovate to linear leaves, whereas *C. racemosa* has ovate leaves. These diagnostic characters are highly variable, found throughout the geographic distribution of *C. racemosa*, and therefore *C. fruticosa* is also recognized here as a synonym of *C. racemosa*.

Native to Mexico, Mesoamerica and northern South America (Graham 2009), *Cuphea hyssopifolia* Kunth is a subshrub cultivated in Rio Grande do Sul and in several regions of Brazil as an ornamental plant. This species is often incorrectly identified as *C. gracilis* Kunth, a non-ornamental species, native to Colombia and Venezuela.

Taxonomic treatment

Cuphea P.Browne, Civ. Nat. Hist. Jamaica 216. 1756. Type (Graham 1968, 2001; Molero & Zijlstra 1999): *Cuphea decandra* W.T.Aiton.

Herbs to subshrubs, stems erect to decumbent, often glandular and strigose; xylopodium sometimes present; rarely tuberous roots present. Leaves opposite to 3–4-verticillate, ovate to elliptic, rarely linear, entire, sessile or petiolate. Inflorescences frondose to bracteate racemes, simple or compound. Flowers zygomorphic, tubular, 6-merous, alternate, opposite to verticillate; pedicels bibracteolate or not; floral tubes 4–14 mm long, persistent in fruiting; spur acute, obtuse to truncate, deflexed, horizontal to ascending; nectar guides 2, at the base of the dorsal sepals, yellow, rarely white; sepals 6, alternating with 6 epicalyx segments; petals 6, subequal to unequal, pink, purple to white, deciduous in the fruit; stamens 11, free in the middle or upper third of the floral tube, included or exserted; vesicles present or absent in the lower region of the stamens insertion; ovary superior, sessile, incompletely bilocular; ovules 4–100+; dorsal nectariferous gland at the base of the ovary. Fruits dry, thin-walled capsules; seeds 1–97+, 0.7–3 × 0.5–2.9 mm, suborbicular, orbicular, obovate to elliptic, apex obtuse, truncate, retuse to emarginate, rarely carunculate, margin obtuse, thinned to thickened, outline entire, rarely erose to dentate, surface green, yellow, purple, dark brown, greenish brown to yellowish green, reddish macules sometimes present, surface ornamentation foveolate, rarely rugose or colliculate.

Key to the *Cuphea* taxa from Rio Grande do Sul

1. Pedicels non-bracteolate; flowers opposite; seeds 0.7–1.1 mm long.
   2. Floral tubes 6–11 mm long; the 2 dorsal petals larger than the 4 ventral petals, concolorous, pink, purple to white ..... 10. *Cuphea racemosa*
   2’. Floral tubes 4–6 mm long; the 2 dorsal petals, purple, and smaller than the 4 ventral petals, white (rarely all white)..... 7. *Cuphea lindmaniana*

1’. Pedicels bibracteolate; flowers alternate to verticillate; seeds 1.3–3 mm long.
   3. Stamens free in the middle third of the floral tube, deeply included.
      4. Stems decumbent; apical leaves elliptic to ovate, lower broadly ovate; vesicles absent in the lower region of the stamens insertion; seed margin obtuse .... 1. *Cuphea calophylla* var. *mesostemon*
      4’. Stems erect; leaves uniformly elliptic; vesicles present in the lower region of the stamens insertion; seed margin thinned ..... 3. *Cuphea carthagenensis*
   3’. Stamens free in the upper third of the floral tube, exserted to subexserted.
      5. Spur ascending.
         6. Leaves ovate to elliptic, base generally cordate to subcordate, rarely obtuse, indumentum strigose, pubescent to glandular, rarely glabrous ..... 6. *Cuphea linarioides*

6'. Leaves linear, base acute to obtuse, glabrous.....8. *Cuphea linifolia*
5'. Spur horizontal to deflexed.
7. Indumentum of the stems strigose and hirsute; seeds apex emarginate to carunculate, margin thinned.
8. Xylopodium present; leaves 3–4-verticillate (rarely opposite); vesicles absent in the lower region of the stamens insertion .....9. *Cuphea lysimachioides*
8'. Xylopodium absent; leaves opposite; vesicles present in the lower region of the stamens insertion.
9. Floral tubes with long glandular trichomes on veins, glabrous between them; seeds apex emarginate, caruncle absent .....2. *Cuphea campylocentra*
9'. Floral tubes uniformly strigose and hirsute; seeds apex with caruncle.....12. *Cuphea urbaniana*
7'. Indumentum of the stems pubescent and glandular; seeds apex truncate to obtuse, margin obtuse to thickened.
10. Xylopodium absent; leaves pubescent and glandular on both surfaces; dorsal petals usually purple and ventral pink (rarely all purple) .....5. *Cuphea glutinosa*
10'. Xylopodium present; leaves strigose on both surfaces, mixed with eglandular erect and glandular trichomes; petals pink to white, concolorous.
11. Leaves with petioles 1–2 mm long or subsessile; 8–11 ovules.....4. *Cuphea confertiflora*
11'. Leaves with petioles 2.5–18 mm long; 14–26 ovules.....11. *Cuphea tuberosa*

1. *Cuphea calophylla* var. ***mesostemon*** (Koehne) S.A.Graham, Syst. Bot. 42(4): 873. 2017.

Figs. 1a-d; 6a-c; 9a

Subshrubs 10–50 cm tall; xylopodium absent; tuberous roots absent; stems decumbent, indumentum pubescent and hirsute, eglandular trichomes short, curved, glandular trichomes long. Leaves opposite, petiole 1–3 mm long, blades 9–35 × 5–25 mm, ovate to elliptic, apical elliptic to ovate, lower broadly ovate, apex acute, rarely rounded, base subcordate to obtuse, indumentum strigose on both surfaces, mixed with long glandular trichomes. Racemes frondose-bracteate, simple to compound. Flowers alternate; pedicels 1.2–7(–10) mm long, bibracteolate; floral tubes 4–8 mm long, spur obtuse, horizontal; outer surface purplish in the dorsal region, greenish ventrally, indumentum pubescent and slightly strigose, glandular trichomes on veins; petals purple to pink, rarely white, subequal; stamens free in the middle third of the floral tube, deeply included; vesicles absent; ovules 7–15; nectariferous gland erect to horizontal. Seeds 4–13, 1.4–2 × 1.3–1.8 mm, suborbicular to broadly elliptic, apex obtuse to truncate, caruncle absent, margin obtuse, outline entire, surface light green to greenish brown, reddish macules sometimes present, foveolate.

Selected material: Alegrete, Res. Biol. Ibirapuitã, X.1985, fl. and fr., *M. Sobral & E. Moraes 4464* (ICN). Cambará do Sul, Cachoeira dos Venâncios, 29º01'02"S, 50º15'38"W, 13.X.2013, fl., *M.G. Facco 338* (ICN). Dom Pedro de Alcântara, Morrinho de Porto Fagundes, 17.I.2009, fl. and fr., *P.J.S. Silva Filho et al. 128* (MPUC). Ijuí, BR-285, km 352, 20.II.1984, fl. and fr., *O. Bueno et al. 3899* (HAS). Palmeira das Missões, BR-158, 27º56'26"S, 53º19'30"W, 3.XII.2011, fl., *M.G. Facco 56* (ICN). Pinhal Grande, Rincão da Ferreira, propriedade do Sr. Normélio Bellé, 29°16'35"S, 53°20'04"W, 4.VI.2011, fl., *M.G. Facco 16* (ICN). Santa Maria, BR-287, 2 km da entrada da Base Aérea, 29º42'24"S, 53º40'29"W, 8.IV.2011, fl. and fr., *M.G. Facco 2* (ICN). Santiago, 29°07'48"S, 54°48'00"W, 30.X.2011, fl., *M.G. Facco* 50 (ICN). São Borja, Barreiros, campestre, 7.XI.1988, fl. and fr., *Equipe do projeto UHE Garabi* (MPUC 8979). Silveira Martins, VRS-804, km 9, 29º39'42"S, 53º36'19"W, 2.IV.2012, fl., *M.G. Facco et al. 167* (ICN). Tenente Portela, 27º22'12"S, 53º45'36"W, 3.XII.2011, fl., *M.G. Facco 58* (ICN). Torres, BR-101, 29º21'09"S, 49º47'52"W, 29.I.2014, fl., *M.G. Facco 311* (ICN).

Cuphea calophylla var. *mesostemon* occurs in Bolivia, Paraguay, Argentina and in eastern and southern Brazil (Graham 2017; Cavalcanti *et al.* 2022b). In Rio Grande do Sul (Fig. 9a), it is recorded in most vegetation formations, in wet and dry grasslands, forest margins, pastures and other disturbed areas, at altitudes between 5–1,020 m. Collected with flowers and fruits practically all year round.

Cuphea calophylla var. *mesostemon* is identified by the decumbent stems (Fig. 1a), lower leaves broadly ovate, small floral tubes (4–8 mm

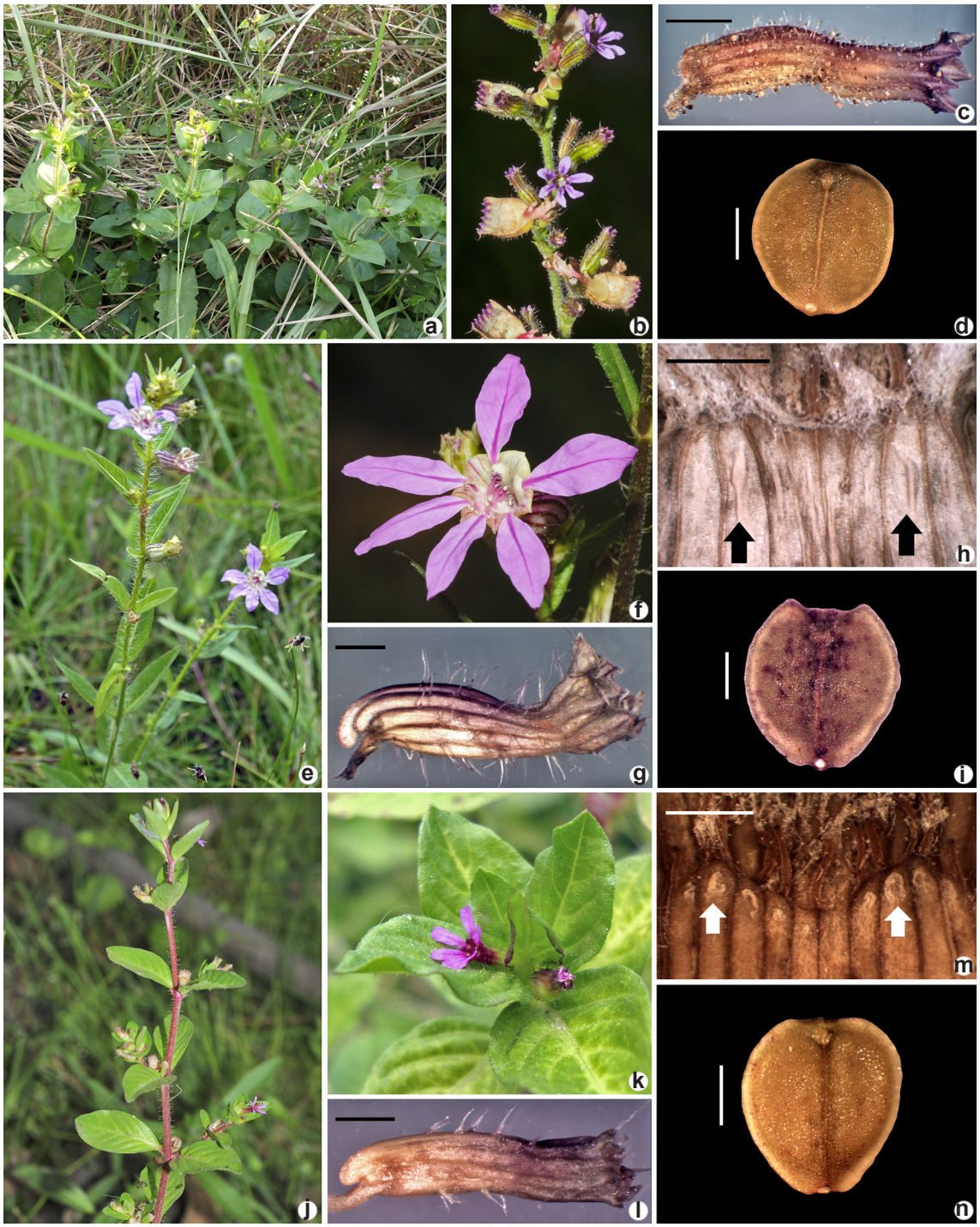

Figure 1 – a-d. *Cuphea calophylla* var. *mesostemon* – a. habit; b. detail of the inflorescence; c. floral tube in lateral view, without the petals; d. seed. e-i. *C. campylocentra* – e. branch with flowers; f. flower; g. floral tube in lateral view, without the petals; h. vesicles (arrows) in the lower region of the stamens insertion; i. seed. j-n. *C. carthagenensis* – j. branch with flowers; k. flowers; l. floral tube in lateral view, without the petals; m. vesicles (arrows) in the lower region of the stamens insertion; n. seed. (c. Facco 16; d. Facco *et al.* 167; g. Facco *et al.* 315; h. Facco & Ferrarese 142; i. Facco *et al.* 154; l-m. Facco *et al.* 102; n. Facco 15). (Photos: a, k. M.G. Facco; b, f, j. S. Bordignon; e. T.S. do Canto Dorow). Bars: c, g. 2 mm; d, h, i, m, n. 0.5 mm; l. 1 mm.

long), stamens free in the middle third of the floral tube, fully included, which indicate autogamy in the species (Graham 1998b), and seed margin obtuse (Figs. 1d; 6a). It can be confused with *C. carthagenensis*, however, this last has erect stems, uniformly elliptic leaves, vesicles present in the lower region of the stamens insertion (Fig. 1m) and seed margin thinned (Fig. 1n; 6h). Both belong to *C.* sect. *Brachyandra*, defined by the deeply included stamens (Koehne 1903; Graham 2017). *Cuphea calophylla* var. *calophylla* and *C. calophylla* var. *fuscinervis* (Koehne) S.A.Graham do not occur in the state of Rio Grande do Sul (Graham 2017). The first is typically distinguished from var. *mesostemon* by lanceolate to elliptic leaves with obtuse to acute bases, and a more erect habit (Graham 2017). The second by the distally imbricate leaves on the stem, oblong to ovate or narrowly elliptic, and by the reddish brown abaxial venation (Graham 2017).

Cuphea calophylla var. *mesostemon* was categorized as "Least Concern (LC)" according to the categories and criteria of the IUCN (2012, 2019), as it is common and widely distributed in the state of Rio Grande do Sul.

2. *Cuphea campylocentra* Griseb., Abh. Königl. Ges. Wiss. Göttingen 24(1): 130. 1879.

Figs. 1e-i; 5; 6d-f; 9a

Subshrubs 15–65 cm tall; xylopodium absent; tuberous roots present; stems erect to decumbent, indumentum strigose-antrorse and hirsute, one-armed appressed trichomes, glandular trichomes long. Leaves opposite, petiole 1–3 mm long, blades 9–43 × 3–20 mm, narrowly elliptic to elliptic, rarely obovate, apex acute to obtuse, base cuneate to attenuate, indumentum strigose on both surfaces, sometimes with long glandular trichomes. Racemes frondose to bracteate, simple to compound. Flowers alternate, rarely opposite; pedicels 1–5 mm long, bibracteolate; floral tubes 8–12 mm long, spur acute to obtuse, strongly deflexed; outer surface purplish in the dorsal region, yellowish-green ventrally, long glandular trichomes on veins, glabrous between them; petals pink to purple, subequal to unequal; stamens free in the upper third of the floral tube, exserted; vesicles present; ovules 16–29; nectariferous gland deflexed. Seeds 4–26, 1.9–2.3 × 1.6–2 mm, suborbicular to elliptic, apex emarginate, caruncle absent, margin thinned, outline entire, surface yellow, green to greenish brown, reddish macules sometimes present, colliculate.

Selected material: Alegrete, Reserva Biológica de Ibirapuitã, 21.III.1998, fl., *R. Wasum* (HUCS 12416). Bagé, campo de várzea junto ao Passo do Viola, 27.III.1984, fl., *A.M. Girardi-Deiro & J.O.N. Gonçalves* (CNPO 848). Dom Pedrito, 12 km D. Pedrito-Livramento, 4.IV.1975, fl., *B. Irgang et al.* (ICN 27397). Esteio, Esteio p. Porto Alegre, 25.X.1950, fl., *B. Rambo 49055* (PACA). Giruá, Granja Sodal, III.1964, fl., *K. Hagelund* (ICN 106962). Júlio de Castilhos, Santa Júlia, 29º16'20"S, 53º44'38"W, 5.II.2014, fl., *M.G. Facco et al. 323* (ICN). Santa Maria, BR-287, próximo ao Posto Pillon, 29º41'22"S, 53º52'24"W, 12.III.2012, fl., *M.G. Facco & M.D. Ferrarese 129* (ICN); BR-287 (Faixa Nova), Hotel Morotin, 29°42'28"S, 53°46'03"W, 19.III.2012, fl., *M.G. Facco & M.D. Ferrarese 142* (ICN); BR-287, Faixa Nova, 29º42'26"S, 53º45'46"W, 22.III.2012, fl., *M.G. Facco et al. 154* (ICN, SMDB); BR-287, Faixa Nova de Camobi, 29°42'29"S, 53°46'00"W, 3.II.2014, fl., *M.G. Facco et al. 315* (ICN). São Borja, Rincão de São Lucas, Estância das Bonitas, 27.III.2003, fl., *R. Záchia 5546* (SMDB). Unistalda, BR-287, 15.I.2013, fl. and fr., *C. Vogel-Ely et al. 37* (ICN).

Cuphea campylocentra occurs in Colombia, Bolivia, Paraguay, Argentina, Uruguay and Brazil, in the states of Mato Grosso do Sul and Rio Grande do Sul (Rodas & Briones 2010; Cavalcanti *et al.* 2022b). In Rio Grande do Sul (Fig. 9a), small populations are found in wet grasslands, and sometimes on roadsides, at altitudes between 10–700 m, in Andropogoneae and Composite mixed grassland, Barba-de-bode grassland, Espinilho grassland and Shortgrass grassland; rarely in the Coastal grassland and Araucaria forest. Collected with flowers and fruits from January to April and October to December.

Cuphea campylocentra, from *C.* sect. *Euandra*, is recognized by the indumentum of the stems which is strigose-antrorse and hirsute, spur strongly deflexed (Fig. 1g), presence of vesicles in the lower region of the stamens insertion (Fig. 1h), and by seeds with emarginate apices, thinned margins, and colliculate surface in SEM (Figs. 1i; 6d-f). In this study, the presence of starch reserve roots, classified here as tuberous roots, was discovered (Fig. 5). The habitats where *C. campylocentra* develops suffer from disturbances such as fire or drought (Fidelis *et al.* 2009), suggesting that the energy reserves of tuberous roots allow rapid regeneration and survival of post-disturbance populations.

Cuphea campylocentra was categorized as "Vulnerable - VU B2ab (i,ii,iii)" in the state of Rio Grande do Sul, according to the categories and criteria of the IUCN (2012, 2019), with an AOO of 64 km² and EOO of 121,352 km². Small

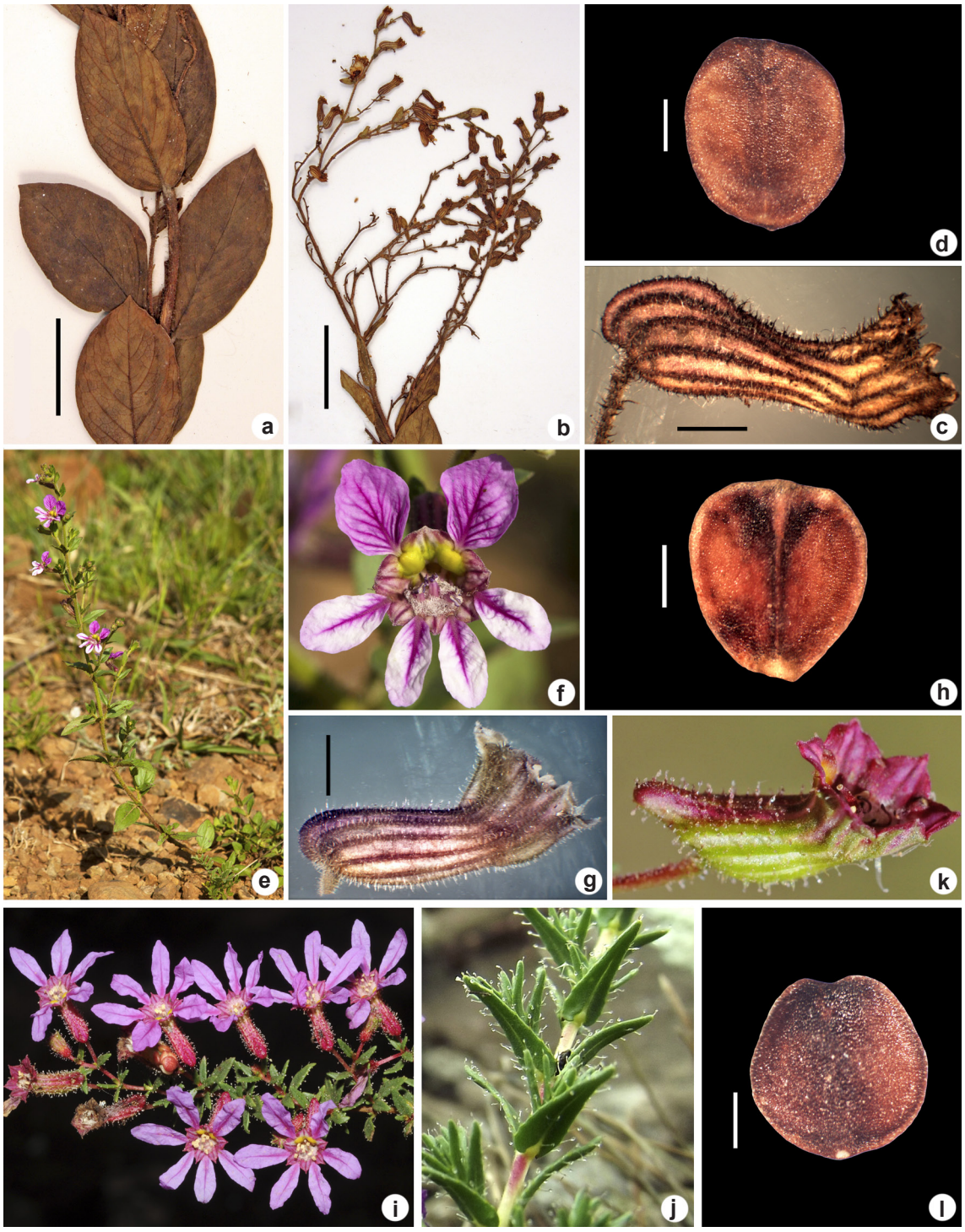

Figure 2 – a-d. *Cuphea confertiflora* – a. detail of a branch; b. detail of the inflorescence; c. floral tube in lateral view, without the petals; d. seed. e-h. *C. glutinosa* – e. habit; f. flower; g. floral tube in lateral view, without the petals; h. seed. i-l. *C. linarioides* – i. branch with flowers; j. detail of a branch. k. floral tube, without the petals; l. seed. (a-d. Frosi *et al.* 359; g. Facco *et al.* 302; h. Facco *et al.* 148; l. Falkenberg 2943). (Photos: e-f. M. Grings; i, k. S. Bordignon; j. M.G. Facco). Bars: a. 2 cm; b. 3 cm; c, g. 2 mm; d, h, l. 0.5 mm.

populations are threatened by the transformation of the wet grasslands into monocultures through drainage, silviculture and urban occupation (Veldman *et al.* 2015; Hasenack *et al.* 2019). In addition, in many regions of Rio Grande do Sul, the collection records are historical.

3. *Cuphea carthagenensis* (Jacq.) J.F.Macbr., Publ. Field Mus. Nat. Hist., Bot. Ser. 8: 124. 1930. Figs. 1j-n; 6g-i; 9b

Herbs to subshrubs 13–91 cm tall; xylopodium absent; tuberous roots absent; stems erect, indumentum hirsute and pubescent, slightly strigose, glandular trichomes long, eglandular trichomes short, curved. Leaves opposite, petiole 1–3 mm long, blades 13–45 × 5–20 mm, elliptic, apex acute, base attenuate to cuneate, indumentum strigose on both surfaces, with sparse glandular trichomes. Racemes frondose to frondose-bracteate, simple to compound. Flowers alternate; pedicels 1–2 mm long, bibracteolate; floral tubes 4–6 mm long, spur obtuse to acute, horizontal to deflexed; outer surface greenish to purplish, glandular trichomes sparse on veins, glabrous between them; petals pink to purple, subequal; stamens free in the middle third of the floral tube, deeply included; vesicles present; ovules 5–9; nectariferous gland erect. Seeds 3–8, 1.4–1.8 × 1.3–1.5 mm, obovate, apex truncate to obtuse, caruncle absent, margin thinned, outline entire, surface brown to light green, reddish macules sometimes present, foveolate.

Selected material: Caçapava do Sul, defronte a pedra do Segredo, 25.III.1985, fl. and fr., *O. Bueno et al. 4124* (HAS). Cambará do Sul, RS-020, 28°52'47"S, 50°01'36"W, 16.II.2012, fl. and fr., *M.G. Facco et al. 102* (ICN); Cachoeira dos Venâncios, 29º01'02"S, 50º15'38"W, 13.X.2013, fl., *M.G. Facco 337* (ICN). Derrubadas, Parque Estadual do Turvo, 27º13'46"S, 53º51'00"W, 3.XII.2011, fl., *M.G. Facco 59* (ICN). Erechim, Vale do Dourado, 27º34'41"S, 52º16'48"W, 13.I.2014, fl., *M.G. Facco et al. 296* (ICN). General Câmara, 29º53'27"S, 51º54'00"W, 7.II.2014, fl., *M.G. Facco & K.A. Freitas 326* (ICN). Montenegro, banhado próximo à BR-287, 29°40'07"S, 51°26'38"W, 14.II.2012, fl. and fr., *M.G. Facco et al. 72* (ICN). Picada Café, BR-116, 29º26'45"S, 51º08'12"W, 14.II.2012, fl., *M.G. Facco et al. 75* (ICN). Pinhal Grande, Rincão da Ferreira, propriedade do Sr. Normélio Bellé, 29°16'35"S, 53°20'04"W, 4.VI.2011, fl. and fr., *M.G. Facco 15* (ICN). Piratini, Serra das Asperezas, VII.2003, fl. and fr., *A.R. Gonçalves* (ICN 128939). Quaraí, BR-293, 18.XII.2013, fl., *M.G. Facco et al. 247* (ICN). Rio Grande, Estação Ecológica do Taim, Lago do Nicola, 32º33'14"S, 52º30'51"W, 5.XII.2013, fl., *M.G. Facco & T.N. Cabreira 231* (ICN). Santa Maria, BR-158, km 355, estrada para Rosário do Sul, 29º45'48"S, 54º02'58"W, 16.IV.2012, fl., *M.G. Facco et al. 173* (ICN).

Cuphea carthagenensis is the most widely distributed species of the genus, found in the United States, Central America and almost all South America (Graham 2017). Adventitious worldwide, is considered an aggressive invader in several countries (Graham 2017). In Rio Grande do Sul (Fig. 9b), it is one of the most abundant species of the genus, occupying all regions, generally forming dense groups in swamps, wet grasslands, pastures, cultivated fields and other disturbed areas, at altitudes between 5–1,100 m. Collected with flowers and fruits all year round.

Cuphea carthagenensis has small floral tubes (4–6 mm long) and stamens free in the middle third of the floral tube, deeply included, related to the autogamous mode of reproduction (Graham 1998b), a remarkable characteristic of most invasive plants (Baker 1974). It is morphologically similar to *C. calophylla* var. *mesostemon*, which differs by the erect stems, elliptic leaves, vesicles present in the lower region of the stamens insertion (Fig. 1m) and by the seed margin thinned (Figs. 1n; 6h). *Cuphea calophylla* var. *mesostemon* has decumbent stems, apical leaves elliptic to ovate, lower leaves broadly ovate, vesicles absent, and seed margin obtuse. Both belong to *C*. sect. *Brachyandra* (Koehne 1903; Graham 2017).

Cuphea carthagenensis was categorized as "Least Concern (LC)", according to the categories and criteria of the IUCN (2012, 2019), as it is common and widely distributed in the state of Rio Grande do Sul.

4. *Cuphea confertiflora* A.St.-Hil., Fl. Bras. Merid. 3: 112. 1833. Figs. 2a-d; 6j-l; 9b

Subshrubs 15–50 cm tall; xylopodium present; tuberous roots absent; stems erect, indumentum pubescent and hirsute, eglandular trichomes short, curved, glandular trichomes long, rare rigid, erect trichomes. Leaves opposite, petioles 1–2 mm long to subsessile, blades 22–47 × 8–26 mm, elliptic to ovate, apex acute, rarely slightly cuspidate, base obtuse, indumentum strigose on both surfaces, mixed with eglandular erect and glandular trichomes. Racemes bracteate, simple to compound. Flowers alternate; pedicels 2–5 mm long, bibracteolate; floral tubes 8–11 mm long, spur obtuse, horizontal to slightly deflexed; outer surface dark purple, indumentum glandular and hispid; petals light pink, unequal, the 2 dorsal petals generally wider than the 4 ventral; stamens

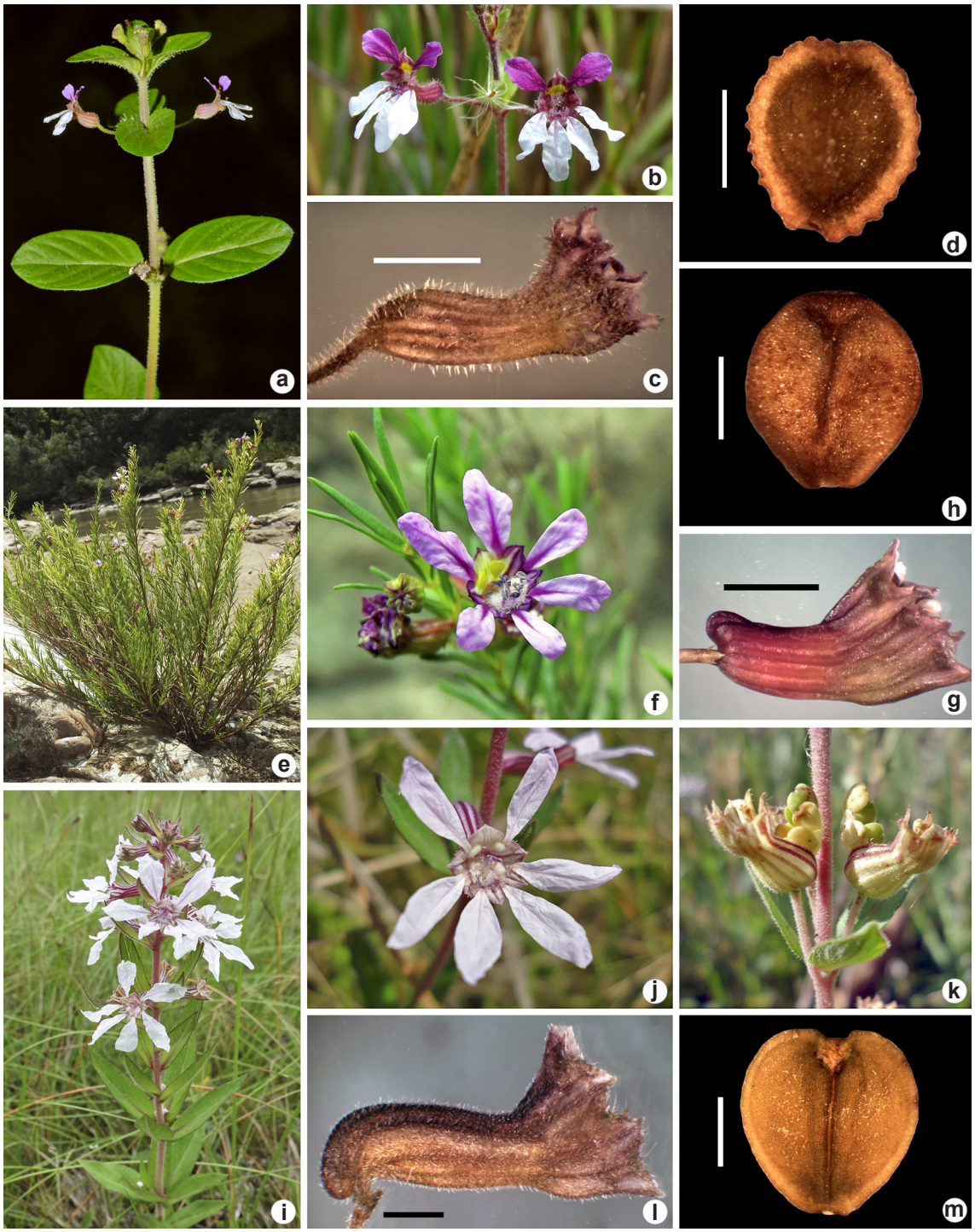

Figure 3 – a-d. *Cuphea lindmaniana* – a. branch with flowers; b. flowers; c. floral tube in lateral view, without the petals; d. seed. e-h. *C. linifolia* – e. habit; f. flower; g. floral tube in lateral view, without the petals; h. seed. i-m. *C. lysimachioides* – i. branch with flowers; j. flower; k. floral tubes with exposed placenta, bearing seeds; l. floral tube in lateral view, without the petals; m. seed. (c-d. Facco *et al.* 259; g-h. Facco 313; l-m. Facco *et al.* 316). (Photos: a. S. Bordignon; b, e, f, j, k. M.G. Facco; i. T.S. do Canto Dorow). Bars: c, g, l. 2 mm; d, h. 0.5 mm; m. 1 mm.

free in the upper third of the floral tube, exserted; vesicles absent; ovules 8–11; nectariferous gland deflexed. Seeds 5–10, 1.8–2 × 1.6–1.8 mm, elliptic to suborbicular, apex obtuse, caruncle absent, margin obtuse, outline entire, surface dark brown to purplish, foveolate.

Examined material: Nonoai, Nonoai *ad fl.* Uruguai, III.1945, fl., *B. Rambo 28603* (PACA); Parque Florestal, na tropeira da campininhas, cerca de 11 km da sede, 26.II.1985, fl. and fr., *R. Frosi et al. 359* (HAS).

Additional material examined: ARGENTINA. MISIONES: Cainguás, Ruta prov. 8, 8.III.2011, fl. and fr., *H.A. Keller & N.G. Paredes 9987* (CTES). BRAZIL. PARANÁ: Guarapuava, Lagoa Sêca, 4.XII.1969, fl. and fr., *G. Hatschbach & P.F. Ravenna 23106* (MBM).

Cuphea confertiflora occurs in Argentina, Paraguay and Brazil, in the states of Paraná and Rio Grande do Sul (Graham & Cavalcanti 2013; Cavalcanti *et al.* 2022b). In Rio Grande do Sul (Fig. 9b), this species is restricted to the extreme north of the state, on riverbanks and at the edges of the Araucaria forest, exclusive to the Atlantic Rainforest, at altitudes between 540–622 m. Collected with flowers in February and March, and with fruits in February.

Cuphea confertiflora has bracteate racemes, with many flowers (Fig. 2b), usually dark purple. It can be confused with the partially sympatric species *C. tuberosa*. However, *C. confertiflora* has subsessile leaves or petioles 1–2 mm, and 8–11 ovules, while *C. tuberosa* has longer petioles, 2.5–18 mm, and 14–16 ovules. Both species belong to *C.* sect. *Euandra* subsect. *Oidemation* and presents a globular to elongated xylopodium, an underground structure related to fire resistance that defines the subsection (Graham & Cavalcanti 2013).

Cuphea confertiflora was categorized as "Critically Endangered - CR B2ab(i,ii,iii)" in the state of Rio Grande do Sul, according to the categories and criteria of the IUCN (2012, 2019), and published in State Decree (Decree No. 52,109, of December 1, 2014). Restricted to the municipality of Nonoai, the species is threatened by monocultures that advance over native vegetation (Veldman *et al.* 2015; Hasenack *et al.* 2019). Known in Rio Grande do Sul only by historical records of herbaria, the AOO of the species is 8 km².

5. *Cuphea glutinosa* Cham. & Schltdl., Linnaea 2: 369. 1827. Figs. 2e-h; 7a-c; 10a

Herbs to subshrubs 13–42 cm tall; xylopodium absent; tuberous roots absent; stems erect to decumbent, indumentum pubescent and glandular, eglandular trichomes curved to erect, glandular trichomes short. Leaves opposite, rarely 3-verticillate, petioles 2–5 mm long or subsessile, blades 3–32 × 1–13 mm, narrowly ovate to ovate, narrowly elliptic to elliptic, apex acute, base obtuse to attenuate, indumentum pubescent and glandular in both surfaces, rarely glabrescent. Racemes frondose to bracteate, simple to compound. Flowers alternate; pedicels 1–3 mm long, bibracteolate; floral tubes 6–10 mm long, spur obtuse, horizontal to slightly deflexed; outer surface purple to vinaceous in the dorsal region, greenish ventrally, indumentum glandular and pubescent; dorsal petals purple and ventral pink, rarely all purple, unequal, the 2 dorsal petals wider than the 4 ventral; stamens free in the upper third of the floral tube, exserted to subexserted; vesicles absent; ovules 8–15; nectariferous gland deflexed, rarely horizontal. Seeds 3–12, 1.5–2.1 × 1.7–2 mm, obovate to suborbicular, apex truncate, caruncle absent, margin thickened, outline entire, surface purple, light green to dark yellow, reddish macules sometimes present, foveolate.

Selected material: Alegrete, BR-290, km 535, 20.XI.1987, fl. and fr., *H.L.-Wagner et al. 1670* (ICN). Bagé, no km 101 da rodovia Bagé-Caçapava do Sul, 30.IX.1982, fl. and fr., *J. Mattos 24620* (HAS). Barra do Quaraí, 17.XI.1991, fl. and fr., *A.A. Filho et al.* (SMDB 4483). Bom Jesus, entre Bom Jesus e Rio Pelotas e Rio Pelotas a Ausentes, 14.X.2004, fl., *I. Boldrini et al. 1427* (ICN). Caçapava do Sul, Guaritas, RS-625, 30º47'58"S, 53º30'44"W, 7.III.2012, fl., *M.G. Facco et al. 124* (ICN). Canela, banhado próximo à Av. José Luiz Corrêa Pinto, 29º21'58"S, 50º49'29"W, 14.II.2012, fl., *M.G. Facco et al. 77* (ICN, SMDB). Ijuí, estrada p/ Santo Ângelo, BR-285, km 473, 14.XI.2000, fl. and fr., *M.R. Ritter 1232* (ICN). Porto Alegre, Morro Santa Teresa, 30º04'26"S, 51º14'02"W, 8.V.2013, fl., *M.G. Facco 346* (ICN). Santa Maria, BR-287, Faixa Nova, 22.III.2012, fl., *M.G. Facco et al. 148* (ICN); BR-287, estrada para São Pedro do Sul, 14.X.2012, fl., *M.G. Facco et al. 202* (ICN). Santana do Livramento, RS-183, estrada para o Passo da Guarda, 30º42'11"S, 55º48'47"W, 18.XII.2013, fl., *M.G. Facco et al. 244* (ICN). Santo Ângelo, Granja do Sossego, 28°15'38"S, 54°15'06"W, 16.I.2014, fl., *M.G. Facco et al. 302* (ICN).

Cuphea glutinosa occurs in Argentina, Bolivia, Paraguay, Uruguay and in eastern and southern Brazil (Cavalcanti & Graham 2002; Cavalcanti *et al.* 2022b). It is one of the most abundant species of *Cuphea* in Rio Grande do Sul, generally found in almost all grassland formations (Fig. 10a), in grasslands with rocky outcrops, wet grasslands and, sometimes, in pastures and roadsides, at altitudes between 10–1,200 m. Collected with flowers and fruits throughout the year.

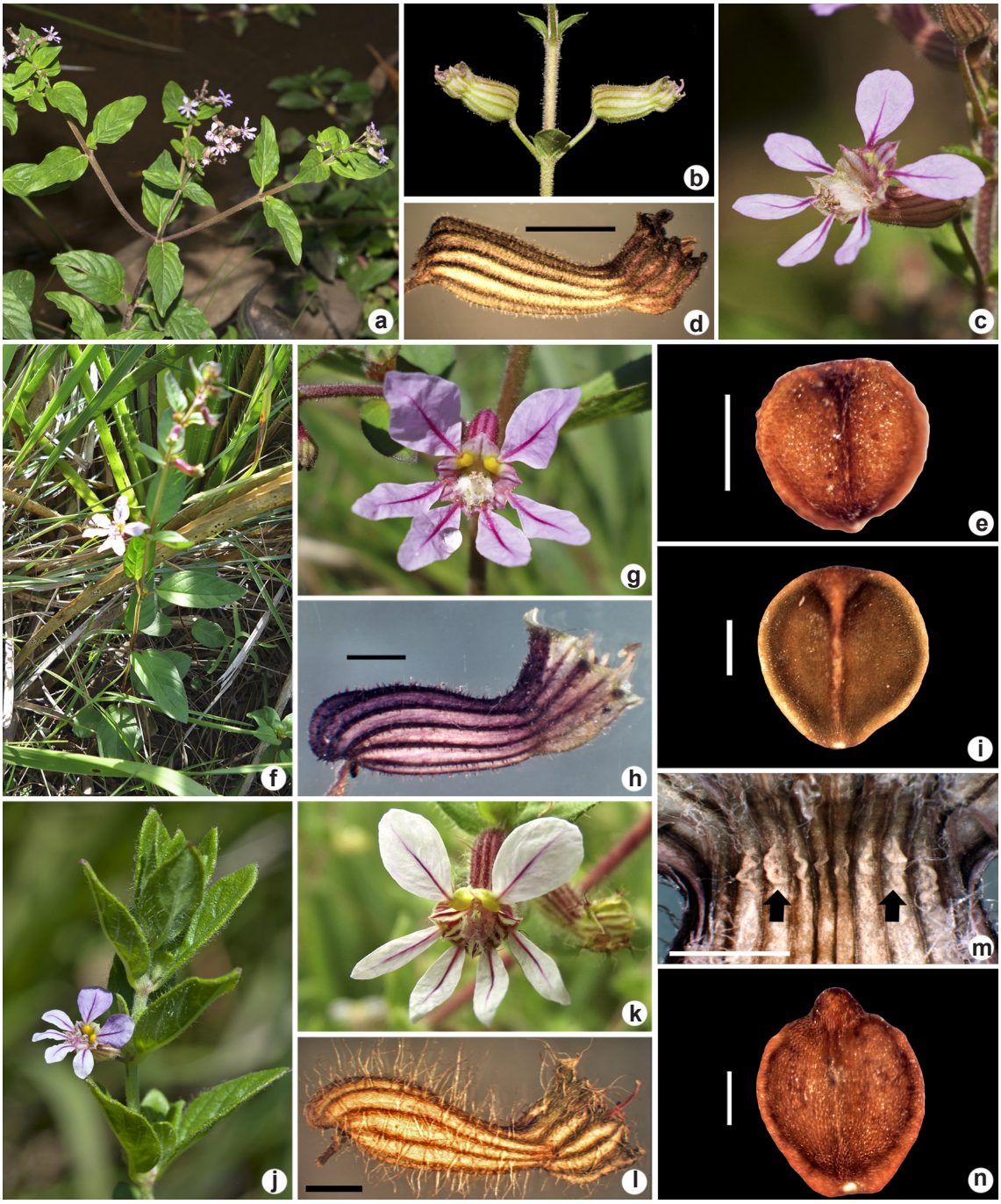

Figure 4 – a-e. *Cuphea racemosa* – a. habit; b. branch with flowers; c. flower; d. floral tube in lateral view, without the petals; e. seed. f-i. *C. tuberosa* – f. habit; g. flower; h. floral tube in lateral view, without the petals; i. seed. j-n. *C. urbaniana* – j. branch with flower; k. flower; l. floral tube in lateral view, without the petals; m. vesicles (arrows) in the lower region of the stamens insertion; n. seed. (d. Facco *et al.* 155; e. Facco 18; h. Facco & Forgiarini 221; i. Facco 65; l. Facco *et al.* 263; m. Facco *et al.* 275; n. Facco *et al.* 76). (Photos: a-c, j. S. Bordignon; f, g, k. M.G. Facco). Bars: d, h, l. 2 mm; e, i, n. 0.5 mm; m. 1 mm.

Cuphea glutinosa has generally decumbent stems (Fig. 2e), and the two dorsal petals, purple, larger than the 4 ventral petals, pink (Fig. 2f), rarely all purple. It belongs to *C*. sect. *Euandra* and is very close to *C. thymoides*, which does not occur in Rio Grande do Sul (Cavalcanti *et al*. 2022b). *Cuphea thymoides* is recognized by its fasciculate, often hyphodromous leaves, plants dark when dried, and seed margin thinned (Cavalcanti & Graham 2002; Cavalcanti *et al.* 2022b). In *C. glutinosa*, the leaves are opposite, never fasciculate, with the secondary veins visible, plants never dark when dried (usually brown), and seeds margin thickened.

Cuphea glutinosa was categorized as "Least Concern (LC)", according to the categories and criteria of the IUCN (2012, 2019), as it is common and widely distributed in the state of Rio Grande do Sul.

6. *Cuphea linarioides* Cham. & Schltdl., Linnaea 2: 367. 1827. Figs. 2i-l; 7d-f; 10a

Subshrubs 17–37 cm tall; roots thickened or xylopodium; tuberous roots absent; stems erect to decumbent, indumentum pubescent, with sparse glandular trichomes. Leaves opposite to verticillate, sessile to subsessile, blades 2.5–11 × 0.5–5 mm, ovate to elliptic, apex acute, base cordate to subcordate, rarely obtuse, indumentum strigose to pubescent on both surfaces, with sparse glandular trichomes, rarely glabrous. Racemes frondose-bracteate, compound. Flowers alternate, rarely opposite; pedicels 1.5–15 mm long, bibracteolate; floral tubes 6–9 mm long, spur acute, ascending; outer surface purplish to vinaceous in the dorsal region, greenish ventrally, indumentum glandular and pubescent; petals purple to pink, unequal, the 2 dorsal petals wider than the 4 ventral; stamens free in the upper third of the floral tube, exserted to subexserted; vesicles absent; ovules 4–7; nectariferous gland deflexed. Seeds 2–7, 1.6–1.8 × 1.4–1.9 mm, suborbicular to elliptic, rarely obtriangular, apex truncate to slightly retuse, caruncle absent, margin obtuse to slightly thickened, outline entire, surface dark brown, foveolate.

Selected material: Arroio dos Ratos, Morro Gateado, 23.I.2013, fl., *C. Vogel-Ely & S. Bordignon 36* (ICN). Caçapava do Sul**,** Guaritas, RS-625, 30º47'58"S, 53º30'44"W, 7.III.2012, fl. and fr., *M.G. Facco et al. 125* (ICN, SMDB); Minas do Camaquã, 29.XI.2012, fl., *C. Vogel-Ely & G.E.F. Silva 29* (ICN). Canela, Laje de Pedra, 25.IV.1976, fl. and fr., *S. Miotto 42* (ICN). Caxias do Sul, distrito de Criúva, 28º52'21"S, 50º58'26"W, 31.I.2014, fl. and fr., *M.G. Facco 312* (ICN). Porto Alegre, Morro da Extrema, 25.VIII.2004, fl. and fr., *R.M. Senna & C. Mansan 638* (HAS). Santana da Boa Vista, Fazenda Santo Antônio, 30.III.1975, fl. and fr., *A. Sehnem 61975* (HUCS, PACA). São Francisco de Paula, estrada para o Pró-Mata, 29º23'58"S, 50º19'36"W, 6.I.2014, fl. and fr., *M.G. Facco et al. 257* (ICN, MBM). Torres, nas dunas da praia de Itapeva, 25.IX.1985, fl., *N. Silveira et al. 3451* (HAS); próximo ao trevo BR-101, 26.X.1985, fl. and fr., *D.B. Falkenberg 2943* (FLOR). Vacaria, Passo do Socorro, 28.I.1951, fr., *A. Sehnem* (PACA 84921).

Cuphea linarioides occurs in Argentina, Paraguay and in eastern and southern Brazil (Cavalcanti & Graham 2002; Cavalcanti *et al.* 2022b). In Rio Grande do Sul (Fig. 10a), the populations of *C. linarioides* are almost restricted to grasslands with rocky outcrops, in the Highland grassland, Andropogoneae and Composite mixed grassland (hills of the city of Porto Alegre) and in the Bush grassland. It is rare in the northeast portion of the Coastal grassland and on the edges of the Araucaria forest. The altitudinal range is 12–1,000 m. Collected with flowers and fruits from January to May and August to December.

Cuphea linarioides is recognized by the ovate to elliptic leaves, with a cordate to subcordate base (Fig. 2j), rarely obtuse, and by the ascending spur (Fig. 2k). It is morphologically close to *C. linifolia*; however, this species generally presents linear and glabrous leaves, with acute to obtuse base, occurring among rocks along riverbanks (Fig. 3e). Both belong to *C*. sect. *Euandra*, the largest of the genus (Koehne 1903).

Cuphea linarioides was categorized as "Least Concern (LC)", according to the categories and criteria of the IUCN (2012, 2019), as it is relatively well-distributed in the state of Rio Grande do Sul.

7. *Cuphea lindmaniana* Koehne *ex* Bacig., Contr. Gray Herb. 95: 6. 1931. Figs. 3a-d; 7g-i; 10b

Herbs 12–60 cm tall; xylopodium absent; tuberous roots absent; stems erect to decumbent, indumentum hirsute and pubescent, glandular trichomes long, eglandular trichomes short, curved. Leaves opposite, petiole 1–10 mm long, blades 7–30 × 2–15 mm, ovate to elliptic, apex acute to obtuse, base cuneate to obtuse, indumentum hirsute, sometimes strigose and pubescent, on both surfaces. Racemes frondose to frondose-bracteate, generally simple. Flowers opposite; pedicels 4–11 mm long, bracteoles absent; floral tubes 4–6 mm long, spur truncate to obtuse, horizontal;

outer surface purplish to vinaceous, indumentum glandular, with few eglandular trichomes short; the 2 dorsal petals purple to pink, the 4 ventral white, rarely all white, unequal, the dorsal petals smaller than the ventral; stamens free in the upper third of the floral tube, exserted to subexserted; vesicles absent; ovules 28–62; nectariferous gland erect to oblique. Seeds 12–44, 0.8–1.1 × 0.8–1 mm, obovate to elliptic, apex truncate, obtuse to retuse, caruncle absent, margin thinned, outline erose to dentate, surface yellowish green to purple, rugose and foveolate.

Selected material: Alegrete, Escola Agrotécnica Federal de Alegrete, em baixada úmida próxima ao arroio Lajeado, III.1986, fl. and fr., *S. Bordignon* (ICN 84021). Bom Jesus, Arroio do Fundo do Cilho, 9.I.2005, fl., *R. Wasum 2374* (HUCS). Cambará do Sul, RS-020, 29º09'58"S, 50º11'46"W, 17.II.2012, fl., *M.G. Facco et al. 100* (ICN); RS-427, estrada para o Cânion Itaimbezinho, 29°08'30"S, 50°04'55"W, 7.I.2014, fl., *M.G. Facco et al. 259* (ICN). Capão do Leão, Av. Eliseu Maciel, perto da UFPel, 31º47'42"S, 52º24'29"W, 3.XII.2013, fl., *M.G. Facco et al. 225* (ICN). Caxias do Sul, Vila Seca, 30.IV.2005, fl., *F. Marchett 211* (HUCS). Muitos Capões, Estação Ecológica de Aracuri, 28º14'01"S, 51º10'21"W, 9.I.2014, fl., *M.G. Facco et al. 284* (ICN). Passo Fundo, Campos da Estação Experimental de Passo Fundo, IX.1949, fl., *Sacco 56* (PACA). Rio Grande, Capilha, 19.XII.2012, fl. and fr., *C. Vogel-Ely et al. 32* (ICN). São Gabriel, Cerro do Ouro, 30º34'58"S, 54º01'14"W, 15.XI.2013, fl. and fr., *P.J.S. Silva Filho & R.B. Macedo 2035* (ICN). São José dos Ausentes, RS-020, 28º49'42"S, 50º00'02"W, 16.II.2012, fl., *M.G. Facco et al. 104* (ICN, SMDB).

Cuphea lindmaniana occurs in Uruguay and in the southern region of Brazil (Lourteig 1969; Cavalcanti *et al.* 2022b). In Rio Grande do Sul (Fig. 10b), it is often found above 400 m, in the Highland grassland. It extends through the Barba-de-bode grassland, Bush grassland and Sandy grassland, and less frequently in Shallow soil grassland, Shortgrass grassland and Coastal grassland. The species grows in swamps, wet grasslands, rarely on the banks of rivers and lakes, at altitudes between 5–1,200 m. Collected with flowers and fruits from January to May and September to December.

Cuphea lindmaniana is morphologically similar to *C. racemosa*, due to the opposite flowers (Fig. 3a,b) and absence of bracteoles on the pedicel, besides the habitat. In *C. lindmaniana*, the floral tubes are smaller (4–6 mm long) and the 2 dorsal petals usually purple, are smaller than the 4 ventral, white (Fig. 3b), rarely all white. While *C. racemosa* has larger floral tubes (6–11 mm long) and the 2 dorsal petals are larger than the 4 ventral ones, concolorous (pink, purple to white). In addition, *C. lindmaniana* differs from the rest of the species by the large number of ovules (28–62) and small seeds, 0.8–1.1 × 0.8–1 mm, with thinned margin, and erose to dentate outline, and a rugose and

Figure 5 – a-b. *Cuphea campylocentra* – a. tuberous roots; b. cross-section of the root, under a light microscope. Dark spots are starches, stained with lugol. (a-b. Facco & Ferrarese 142). Bar: b. 200 µm

foveolate surface in SEM (Fig. 7g-i). Both species are representatives of *C*. sect. *Cuphea* (Koehne 1903).

Cuphea lindmaniana was categorized as "Least Concern (LC)", according to the categories and criteria of the IUCN (2012, 2019), as it is relatively well-distributed in the state of Rio Grande do Sul.

8. *Cuphea linifolia* (A.St.-Hil.) Koehne, *Fl. bras.* 13(2): 282, pl. 51, fig. 2. 1877. Figs. 3e-h; 7j-l; 10b

Subshrubs 9–35 cm tall; roots thickened; xylopodium absent; tuberous roots absent; stems usually erect, indumentum pubescent, eglandular trichomes short, erect. Leaves opposite, subsessile, blades 4–17 × 0.8–1.2 mm, linear, rarely narrowly ovate, apex acute, base acute to obtuse, glabrous. Racemes frondose to frondose-bracteate, simple to compound. Flowers alternate; pedicels 2–4 mm long, bibracteolate; floral tubes 5–7 mm long, spur acute, ascending; outer surface vinaceous in the dorsal region, greenish ventrally, glabrous or glandular trichomes on veins; petals pink to lilac, rarely white, unequal, the 2 dorsal petals wider than the 4 ventral; stamens free in the upper third of the floral tube, exserted to subexserted; vesicles absent; ovules 6–8; nectariferous gland deflexed. Seeds 1–3, 1.3–1.4 × 1.2–1.3 mm, suborbicular to elliptic, apex obtuse to slightly truncate, caruncle absent, margin obtuse to slightly thickened, outline entire, surface purplish green, foveolate.

Selected material: Bom Jesus, margem do Rio dos Touros, 28º25'21"S, 50º29'26"W, 14.X.2013, fl. and fr., *M.G. Facco 342* (ICN); Rio Pelotas, 28º24'41"S, 50º30'13"W, 14.X.2013, fl. and fr., *M.G. Facco 344* (FURB, ICN); Rio das Antas, 28º48'04"S, 50º40'47"W, 27.III.2014, fl. and fr., *P.J.S. Silva Filho 2051* (ICN). Caxias do Sul, distrito de Criúva, Ponte do Korff, Rio das Antas, 28º49'42"S, 51º00'26"W, 31.I.2014, fl. and fr., *M.G. Facco 313* (FLOR, ICN, MBM). Pinto Bandeira, UHE-Monte Claro, margem esq. do rio, 11.III.2003, fl. and fr., *O. Bueno et al. 7555* (ICN); reservatório da UHE Monte Claro, 16.VI.2004, fl. and fr., *S.M. Marodin* (ICN 123256). Vacaria, Encanados, margem do Rio Pelotas, 18.XII.1997, *R.A. Záchia et al. 2698* (SMDB); Coxilha Grande, Encanadas, 23.I.2005, fl., *M.R. Ritter & M. Dickel* (ICN 170526).

Cuphea linifolia is endemic to Brazil, occurring in the states of Goiás, São Paulo, Paraná and Rio Grande do Sul (Cavalcanti *et al.* 2022b). In Rio Grande do Sul (Fig. 10b), small populations occur on the rocky riverbanks in the northeast of the state, in the Araucaria forest and in the Inland subtropical forest, at altitudes between 230–830 m. Collected with flowers and fruits from January to June and October to December.

Cuphea linifolia is recognized by the linear, rarely narrowly ovate, glabrous leaves, with an acute to obtuse base, and by the ascending spur (Fig. 3g). It is morphologically similar to *C. linarioides*, but in this species the leaves are generally ovate to elliptic, glandular, with a cordate to subcordate base (Fig. 2j). Both belong to *C*. sect. *Euandra* (Koehne 1903).

Cuphea linifolia was categorized as "Endangered - EN B1ab(i,ii,iii)" in the state of Rio Grande do Sul, according to the categories and criteria of the IUCN (2012, 2019), with an AOO of 24 km² and EOO of 4,179 km². This species is threatened by hydropower construction projects (Brack *et al.* 2016), as it occurs on the rocky riverbanks such as the Pelotas river and the Antas river.

9. *Cuphea lysimachioides* Cham. & Schltdl., Linnaea 2: 374. 1827. Figs. 3i-m; 8a-c; 11a

Subshrubs 23–87 cm tall; xylopodium present; tuberous roots absent; stems erect to decumbent, indumentum densely strigose-retrorse, sometimes hirsute, one-armed appressed trichomes, glandular trichomes long. Leaves 3–4 verticillate, rarely opposite, petiole 1–3 mm long, blades 11–48 × 4–16 mm, elliptic to oblong, apex acute, rarely obtuse or cuspidate, base obtuse to cuneate, indumentum densely strigose on both surfaces, sometimes with sparse glandular trichomes. Racemes bracteate to frondose-bracteate, usually simple. Flowers alternate to verticillate, pedicels 3–20 mm long, bibracteolate; floral tubes 8–13 mm long, spur obtuse, deflexed; outer surface purplish in the dorsal region or totally yellowish-green, indumentum strigose, sometimes glandular trichomes present; petals white to pink, subequal; stamens free in the upper third of the floral tube, exserted; vesicles absent; ovules 8–15; nectariferous gland deflexed. Seeds 3–14, 2.2–3 × 2.1–2.9 mm, broadly obovate to suborbicular, apex emarginate, caruncle absent, margin thinned, outline entire, surface yellowish green to dark brown, reddish macules sometimes present foveolate.

Selected material: Alegrete, BR-290, km 562, 20.XI.1987, fl. and fr., *H.L.-Wagner et al. 1663* (ICN). Arroio dos Ratos, Fazenda Faxinal, 30.XI.1977, fl. and fr., *K. Hagelund 12034* (ICN). Cachoeira do Sul, 30º15'51"S, 52º50'57.17"W, 1.XI.2010, fl. and fr., *P.J.S. Silva Filho 1676* (MPUC). Caibaté, Caaró p. S. Luiz, 24.XI.1954,

fl., *B. Rambo 53422* (HBR, PACA). Ijuí, BR-285, km 352, 20.II.1984, fl., *O. Bueno et al. 3898* (HAS). Santa Maria, BR-158, DIMED, 24.X.1980, fl., *A. Alvarez Filho* (SMDB 1832); BR-287 (Faixa Nova), Hotel Morotin, 29º42'28"S, 53º46'03"W, 19.III.2012, fl. and fr., *M.G. Facco & M.D. Ferrarese 139* (ICN); BR-392, em direção à São Sepé, 29°46'20"S, 53°47'02"W, 4.II.2014, fl. and fr., *M.G. Facco et al. 316* (ICN). São Borja, 57 km SE de S. Borja, est. p/ Santiago, 20.XII.1972, fl., *J.C. Lindeman & A. Pott* (ICN 21115). São Pedro do Sul, 3 km do Cerro do Itaquatiá, 29º35'09"S, 54º19'36"W, 7.X.2011, fl. and fr., *M.G. Facco 41* (ICN, MBM). São Vicente do Sul, Cerro Loreto, IX.1987, fl., *M. Sobral et al. 5120* (ICN).

Cuphea lysimachioides occurs in Argentina, Paraguay, Uruguay and Brazil, in the states of Mato Grosso do Sul, Paraná and Rio Grande do Sul (Graham & Cavalcanti 2013; Cavalcanti *et al.* 2022b). In Rio Grande do Sul (Fig. 11a), is found in wet grasslands and swamps, in Andropogoneae and Composite mixed grassland, Barba-de-bode

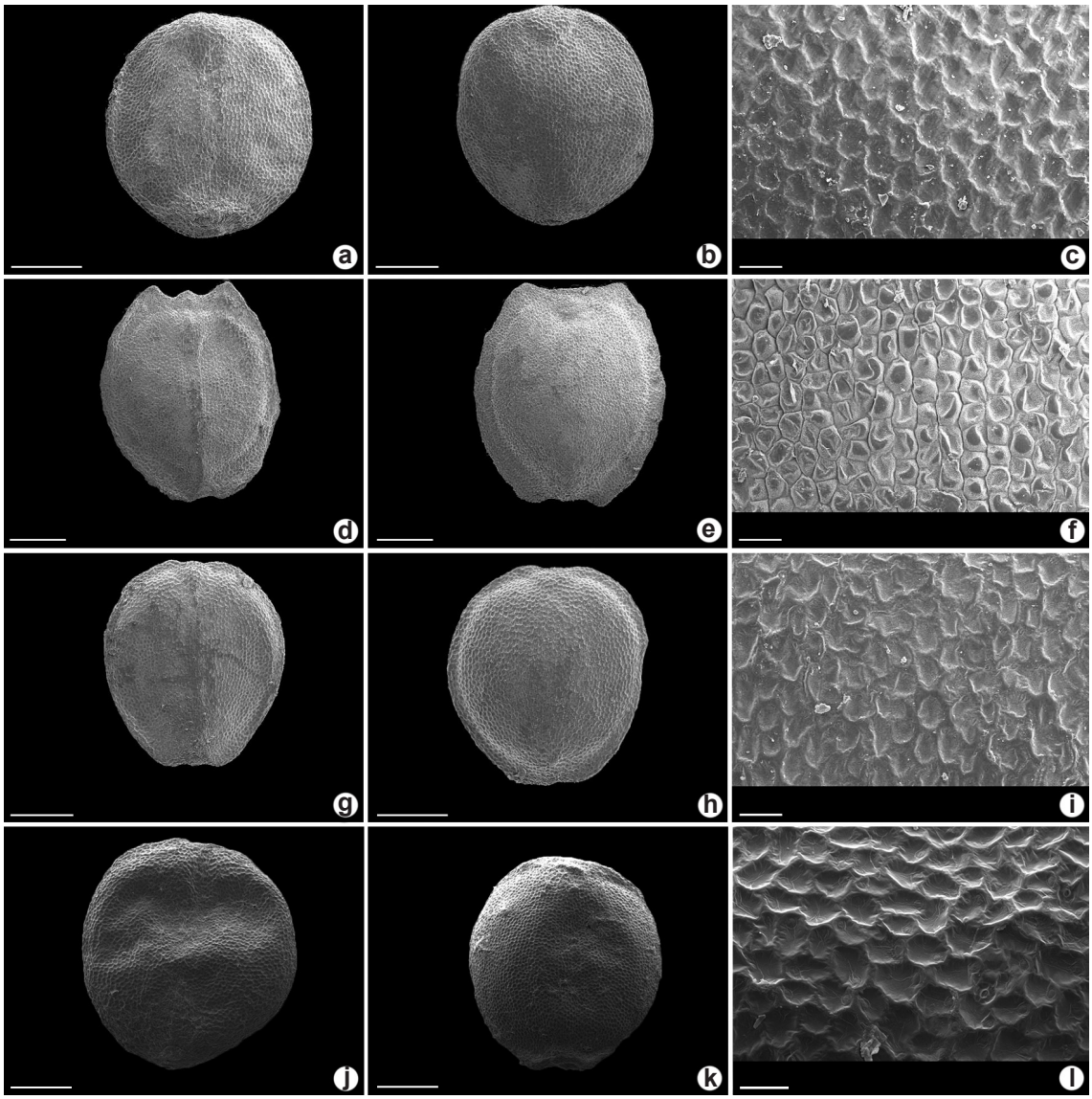

Figure 6 – a-l. SEM photomicrographs of seeds (in dorsal and ventral view, and surface) of *Cuphea* from Rio Grande do Sul – a-c. *C. calophylla* var. *mesostemon* – c. surface foveolate; d-f. *C. campylocentra* – f. surface colliculate; g-i. *C. carthagenensis* – i. surface foveolate; j-l. *C. confertiflora* – l. surface foveolate. (a-c. Facco *et al.* 50; d. Facco & Ferrarese 142; e-f. Facco *et al.* 154; g. Facco 15; h-i. Facco *et al.* 72; j-l. Frosi *et al.* 359). Bars: a-b, d-e, g-h, j-k. 500 µm; c, f, i, l. 50 µm.

grassland, Espinilho grassland, Sandy grassland and Shallow soil grassland, at altitudes between 70–460 m. Collected with flowers from January to April and September to December, with a predominance of fruits from January to March and November to December.

Leaves generally 3–4 verticillate, stem densely strigose-retrorse, large seeds (2.2–3 × 2.1–2.9 mm), with a thinned margin (Figs. 3m; 8b) and the presence of xylopodium differentiate *C. lysimachioides* from other species that occur in Rio Grande do Sul. The presence of xylopodium possibly confers resistance to disturbances such as fire (Graham & Cavalcanti 2013). It belongs to *C*. sect. *Euandra* subsect. *Oidemation* which is defined by the presence of this underground structure (Graham & Cavalcanti 2013).

Cuphea lysimachioides was categorized as "Vulnerable - VU B2ab (i,ii,iii)" in the state of Rio Grande do Sul, according to the categories and criteria of IUCN (2012, 2019), with an AOO

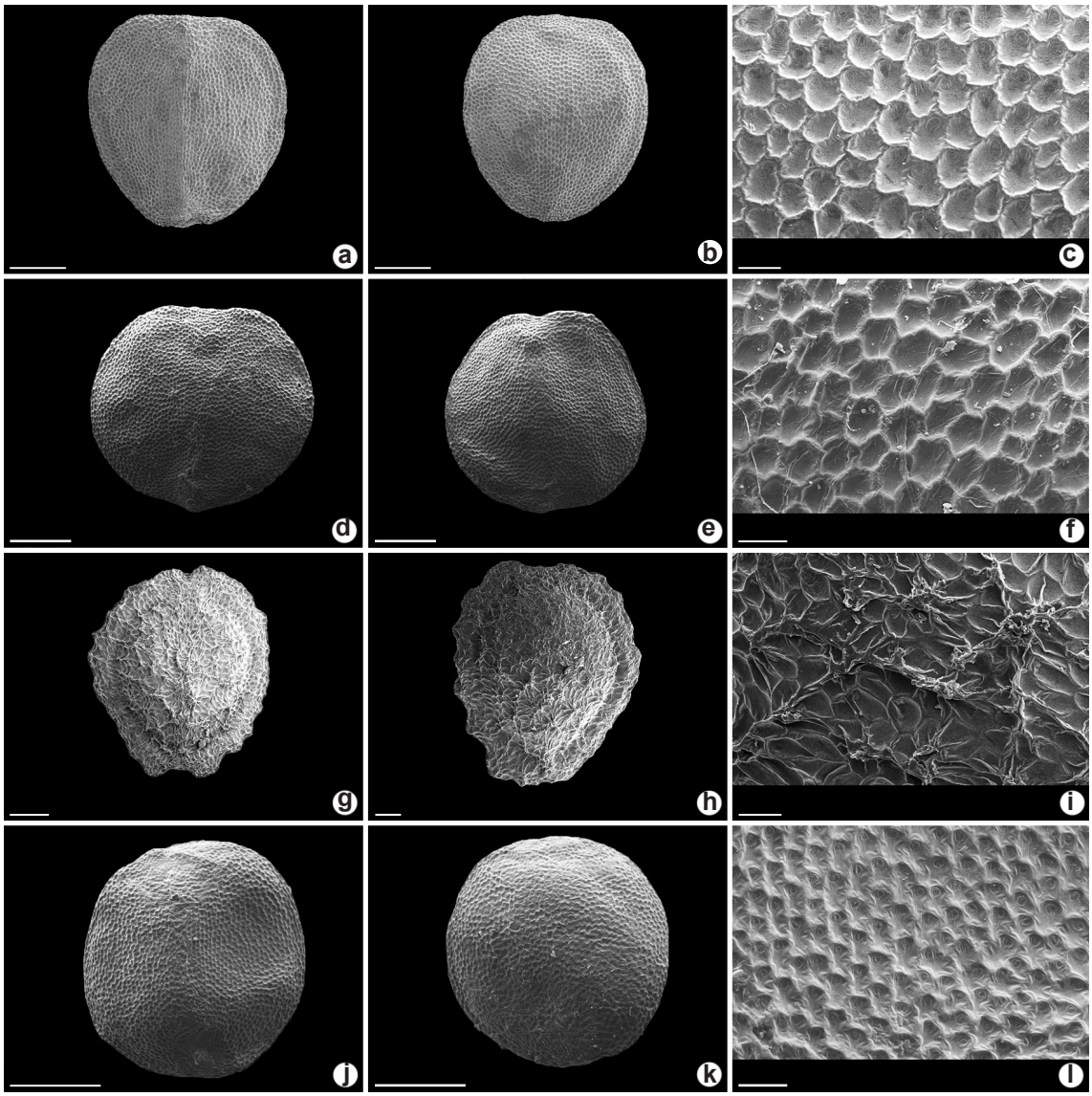

Figure 7 – a-l. SEM photomicrographs of seeds (in dorsal and ventral view, and surface) of *Cuphea* from Rio Grande do Sul – a-c. *C. glutinosa* – c. surface foveolate; d-f. *C. linarioides* – f. surface foveolate; g-i. *C. lindmaniana* – i. surface rugose and foveolate; j-l. *C. linifolia* – l. surface foveolate. (a-c. Facco *et al.* 77; d-f. Falkenberg 2943; g-i. Facco *et al.* 104; j-l. Facco 313). Bars: a-b, d-e, j-k. 500 µm; g. 200 µm; h. 100 µm; c, f, i, l. 50 µm.

of 68 km² and EOO of 57,594 km². The species, characterized by populations with few individuals, is threatened by the increasing suppression of natural grasslands by monocultures and silviculture (Veldman *et al.* 2015; Hasenack *et al.* 2019).

10. *Cuphea racemosa* (L.f.) Spreng., Syst. Veg. 2: 455. 1825. Figs. 4a-e; 8d-g; 11a

Herbs to subshrubs 20–60 cm tall; xylopodium absent; tuberous roots absent; stems erect to decumbent, indumentum pubescent and hirsute, eglandular trichomes short, glandular trichomes long. Leaves opposite, petiole 1–15 mm long, blades 10–60 × 5–26 mm, ovate to elliptic, rarely narrowly ovate, apex acute to obtuse, base obtuse, attenuate to truncate, indumentum pubescent and glandular on both surfaces, sometimes strigose. Racemes generally bracteate, simple to compound. Flowers opposite; pedicels 2–13 mm long, bracteoles absent; floral tubes 6–11 mm long, spur

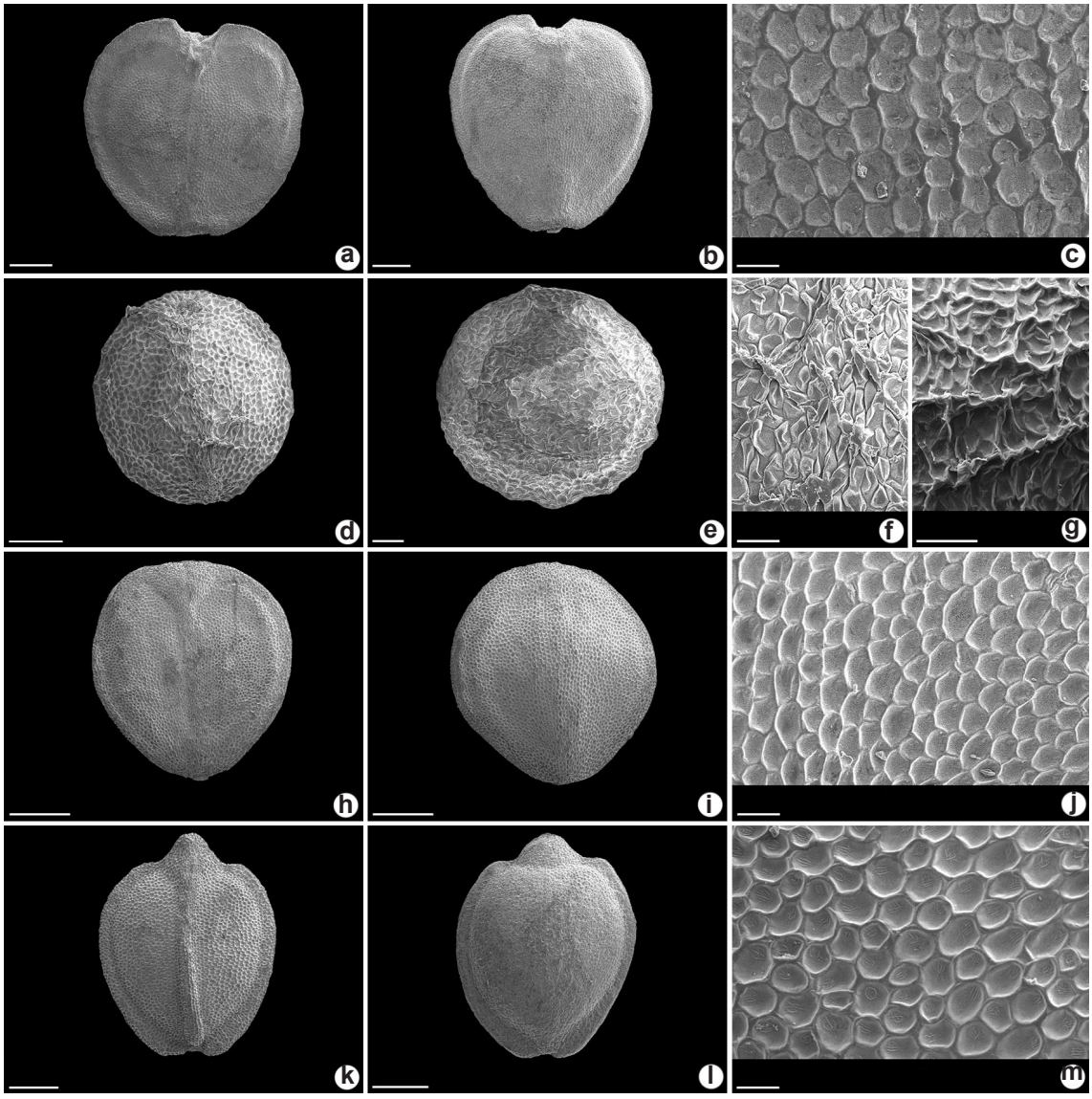

Figure 8 – a-m. SEM photomicrographs of seeds (in dorsal and ventral view, and surface) of *Cuphea* from Rio Grande do Sul – a-c. *C. lysimachioides* – c. surface foveolate. d-g. *C. racemosa* – f. surface rugose and colliculate; g. surface rugose and foveolate. h-j. *C. tuberosa* – j. surface foveolate. k-m. *C. urbaniana* – m. surface foveolate. (a-c. Facco & Ferrarese 139; d-f. Facco & Ferrarese 146; g. Facco 18; h-j. Facco 65; k-m. Facco *et al.* 103). Bars: a-b, h-i, k-l. 500 µm; d. 200 µm; e. 100 µm; c, f, j, m. 50 µm; g. 100 µm.

truncate to obtuse, horizontal; outer surface purple to vinaceous in the dorsal region, yellowish green ventrally, indumentum pubescent and glandular, rarely glabrescent; petals pink, purple to white, unequal, the 2 dorsal petals larger than the 4 ventral; stamens free in the upper third of the floral tube, exserted; vesicles absent; ovules 43–100+; nectariferous gland horizontal to ascending. Seeds (10–)25–97+, 0.7–1 × 0.5–0.9 mm, orbicular, rarely elliptic, apex obtuse, caruncle absent, margin thinned, outline erose to dentate, surface brown, purple to greenish yellow, rugose and foveolate, rarely rugose and colliculate.

Selected material: Agudo, Morro do Agudo, 27.IX.1985, fl. and fr., *D.B. Falkenberg 2623* (FLOR, ICN). Bagé, RS-153, km 67, ponte sobre o Rio Camaquã, 28.III.1985, fl., *O. Bueno et al. 4325* (HAS). Barra do Quaraí, Tríplice Fronteira, 11.IV.2014, fl. and fr., *M.G. Facco 336* (ICN). Caçapava do Sul, BR-153, no trevo para as Guaritas, 20.I.1994, fl. and fr., *D.B. Falkenberg et al. 6387* (FLOR). Pelotas, Fazenda Capão Redondo, a 23 km do IBDF, na rodovia para Jaguarão, 16.I.1981, fl. and fr., *J. Mattos et al. 22271* (HAS). Porto Alegre, Praia do Lami, 30º14'39"S, 51º04'29"W, 8.III.2014, fl. and fr., *M.G. Facco & K.A. Freitas 332* (ICN). Santa Cruz do Sul, beira da estrada, 28.IX.1985, fl. and fr., *D.B. Falkenberg 2618* (ICN). Santa Maria, BR-287, em frente à QUIMEA, 29°42'31"S, 53°48'05"W, 10.VI.2011, fl. and fr., *M.G. Facco 18* (ICN); estrada para São Sepé, BR-392, 25 km do trevo da Uglione, 29º55'10"S, 53º43'32"W, 16.IX.2011, fl. and fr., *M.G. Facco 29* (ICN); BR-287 (Faixa Nova), Hotel Morotin, 29°42'28"S, 53°46'03"W, 19.III.2012, fl. and fr., *M.G. Facco & M.D. Ferrarese 146* (ICN); BR-287, Faixa Nova, 22.III.2012, fl. and fr., *M.G. Facco et al. 155* (ICN). São Francisco de Paula, 18.XII.1949, fl., *A. Sehnem* (HUCS 1396). São Pedro do Sul, 3 km do Cerro do Itaquatiá, 29º35'09"S, 54º19'36"W, 7.X.2011, fl. and fr., *M.G. Facco 43* (ICN).

Cuphea racemosa occurs from Mexico to eastern and southern Brazil (Cavalcanti & Graham 2011; Cavalcanti *et al.* 2022b). It is well distributed in Rio Grande do Sul, occurring in most vegetation formations (Fig. 11a), in wet grasslands, swamps,

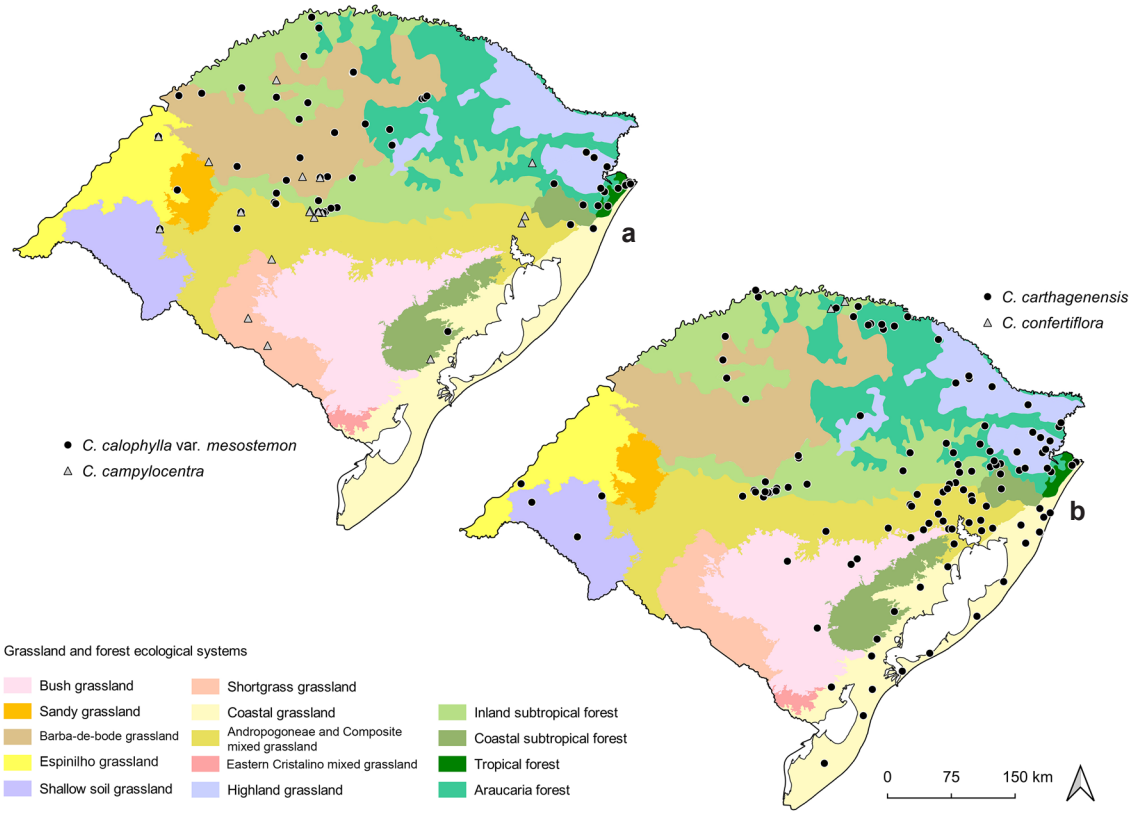

Figure 9 – a-b. Distribution of *Cuphea* species in the state of Rio Grande do Sul – a. *C. calophylla* var. *mesostemon* and *C. campylocentra*; b. *C. carthagenensis* and *C. confertiflora*. (Grassland ecological systems: Hasenack 2017; forest phytoecological regions: IBGE 2012).

riverbanks, wet forest margins and openings, at altitudes between 10–960 m. Collected with flowers and fruits practically all year round.

Cuphea racemosa, from *C.* sect. *Cuphea*, is considered one of the most variable and complex species of the genus (Cavalcanti & Graham 2002). It is recognized by bracteate racemes with opposite flowers (Fig. 4a, b) and pedicels without bracteoles. In addition, it has numerous ovules (43–100+) and small seeds, 0.7–1 × 0.5–0.9 mm, with a thinned margin and erose to dentate outline, and a rugose and foveolate surface in SEM, rarely rugose and colliculate (Figs. 4e; 8d-g). *Cuphea racemosa* can be confused with *C. lindmaniana* but differs from this species by the larger floral tubes (6–11 mm long) and the 2 dorsal petals larger than the 4 ventral ones (Fig. 4c), concolorous, pink, purple to white. In *C. lindmaniana*, the floral tubes are smaller (4–6 mm long) and the 2 dorsal petals usually purple, are smaller than the 4 ventral, white (Fig. 3b), rarely all white.

Cuphea racemosa was categorized as "Least Concern (LC)", according to the categories and criteria of the IUCN (2012, 2019), as it is common and widely distributed in the state of Rio Grande do Sul.

11. *Cuphea tuberosa* Cham. & Schltdl., Linnaea 2: 372. 1827. Figs. 4f-i; 8h-j; 11b

Subshrubs 15–100 cm tall; xylopodium present; tuberous roots absent; stems erect, indumentum pubescent and hirsute, eglandular trichomes short, curved, glandular trichomes long. Leaves opposite, rarely subopposite or verticillate, petiole 2.5–18 mm long, blades 8–62 × 7–29 mm, elliptic to ovate, apex acute to obtuse, rarely slightly cuspidate, base subcordate to obtuse, indumentum strigose on both surfaces, with sparse glandular trichomes. Racemes bracteate to frondose-bracteate, simple to compound. Flowers alternate, rarely opposite; pedicels 2–9 mm long, bibracteolate; floral tubes 8–11 mm

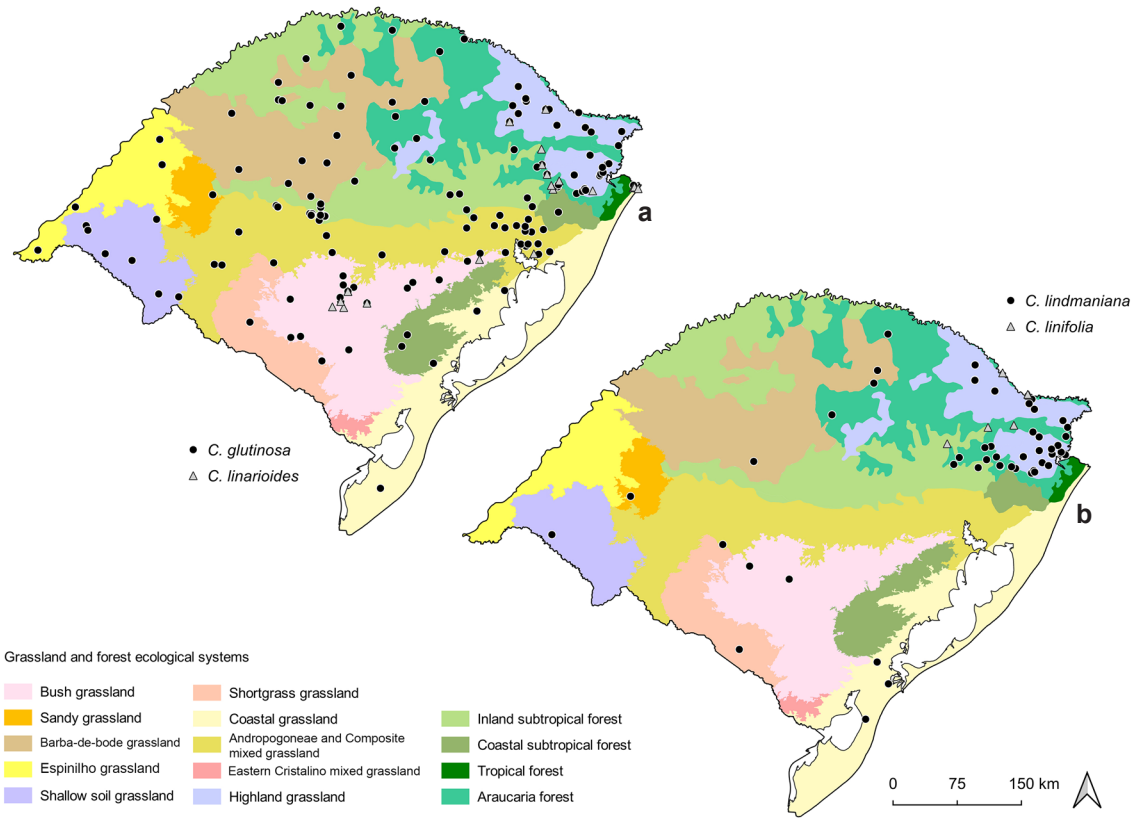

Figure 10 – a-b. Distribution of *Cuphea* species in the state of Rio Grande do Sul – a. *C. glutinosa* and *C. linarioides*; b. *C. lindmaniana* and *C. linifolia*. (Grassland ecological systems: Hasenack 2017; forest phytoecological regions: IBGE 2012).

long, spur obtuse, horizontal to deflexed; outer surface purplish to vinaceous in the dorsal region, greenish ventrally, indumentum pubescent and densely glandular; petals pink to white, unequal, the 2 dorsal petals larger than the 4 ventral; stamens free in the upper third of the floral tube, exserted; vesicles absent; ovules 14–26; nectariferous gland deflexed. Seeds 7–15, 1.6–2 × 1.5–1.9 mm, broadly obovate to suborbicular, apex truncate, caruncle absent, margin thickened, outline entire, surface yellowish green to purple, reddish macules sometimes present, foveolate.

Selected material: Alegrete, BR-290, km 468, 3.IV.1977, fl., *M.L. Porto et al. 2424* (ICN). Amaral Ferrador, estrada para a cidade, 30º44'22"S, 52º23'49"W, 21.XI.2013, fl. and fr., *M.G. Facco & C. Forgiarini 221* (ICN). Candiota, Arroio da Usina, 17.XII.1987, fl., *P. Oliveira et al.* (CNPO 1706). Capão Bonito do Sul, BR-285, estrada para Muitos Capões, 28º17'24"S, 51º25'06"W, 9.I.2014, fl. and fr., *M.G. Facco et al. 285* (ICN, MBM). Palmeira das Missões, BR-158, 205 km de Santa Maria, 27º52'57"S, 53º20'07"W, 17.XII.2011, fl. and fr., *M.G. Facco 65* (ICN, SMDB). Passo Fundo, W de Passo Fundo, 30.X.1971, fl., *J. Lindeman et al.* (HAS 5238). Santa Maria, UFSM, açude atrás do prédio da Educação Física, 29º43'19"S, 53º42'20"W, 3.X.2011, fl. and fr., *M.G. Facco 38* (FLOR, ICN); BR-158, estrada para Rosário do Sul, 29º42'33"S, 53º53'08"W, 16.IV.2012, fl. and fr., *M.G. Facco et al. 176* (ICN). Santana do Livramento, estrada para a Vila Palomas, 9.XII.1986, fl. and fr., *O. Bueno 4805* (HAS). Santo Ângelo, Santo Ângelo para Giruá, 2.IX.2011, fl. and fr., *A.A. Schneider 1735* (ICN).

Cuphea tuberosa occurs in Argentina, Paraguay, Uruguay and the Southern Region of Brazil (Graham & Cavalcanti 2013; Cavalcanti *et al.* 2022b). In Rio Grande do Sul (Fig. 11b), it is found in the Highland grassland, Barba-de-bode grassland, Andropogoneae and Composite mixed grassland, Bush grassland and in the Shallow soil grassland, at altitudes between 80–930 m. It grows in swamps, wet grasslands, riverbanks and roadsides. Collected with flowers and fruits from January to April and August to December.

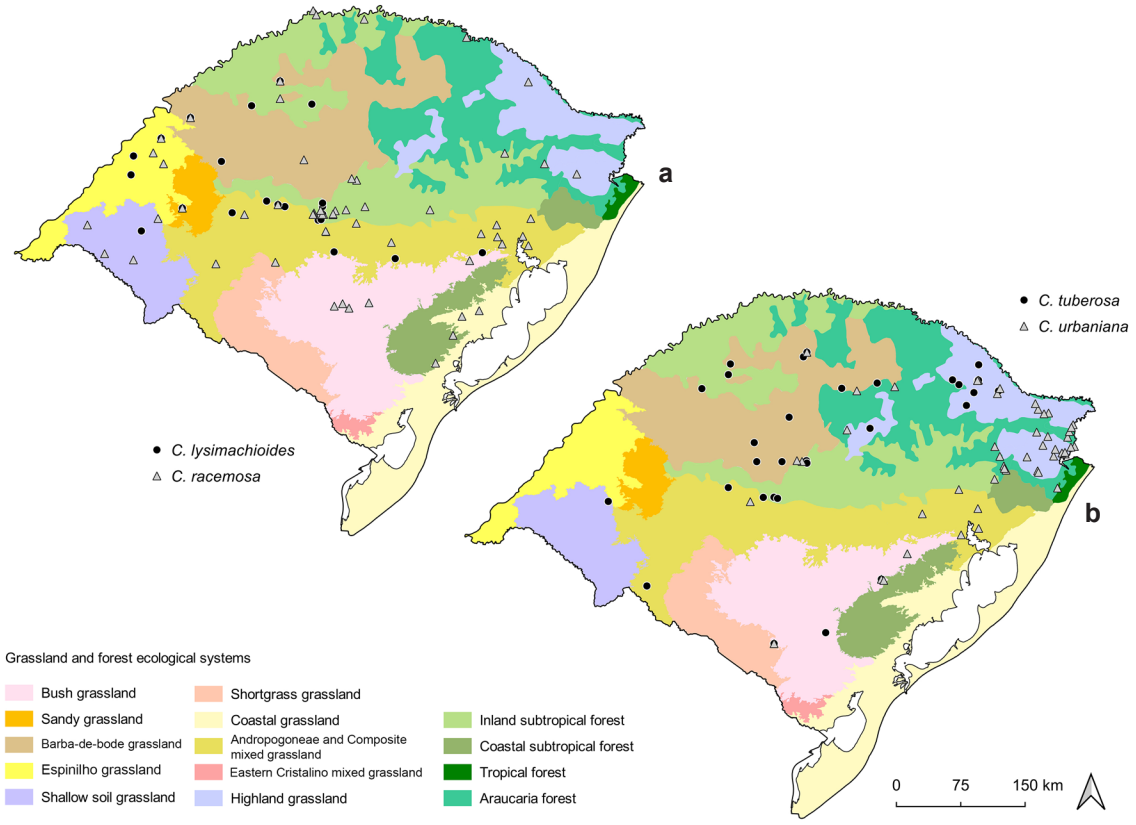

Figure 11 – a-b. Distribution of *Cuphea* species in the state of Rio Grande do Sul – a. *C. lysimachioides* and *C. racemosa*; b. *C. tuberosa* and *C. urbaniana*. (Grassland ecological systems: Hasenack 2017; forest phytoecological regions: IBGE 2012).

Cuphea tuberosa is morphologically similar to *C. confertiflora*. However, *C. tuberosa* has longer petioles, 2.5–18 mm, and 14–16 ovules, while *C. confertiflora* has shorter petioles, 1–2 mm, and 8–11 ovules. Both belong to *C.* sect. *Euandra* subsect. *Oidemation*, which is defined by the presence of xylopodium, associated with fire resistance (Graham & Cavalcanti 2013).

Cuphea tuberosa was categorized as "Least Concern (LC)", according to the categories and criteria of the IUCN (2012, 2019), as it is relatively well-distributed in the state of Rio Grande do Sul.

12. *Cuphea urbaniana* Koehne, Bot. Jahrb. Syst. 2: 152. 1881. Figs. 4j-n; 8k-m; 11b

Subshrubs 30–90 cm tall; xylopodium absent; tuberous roots absent; stems erect to decumbent, indumentum strigose-retrorse and hirsute, one-armed appressed trichomes, glandular trichomes long. Leaves opposite, petiole 1–6 mm long, blades 6–45 × 3–15 mm, narrowly elliptic, elliptic to ovate, apex acute, base cuneate to obtuse, indumentum strigose on both surfaces, sometimes long glandular trichomes present. Racemes frondose-bracteate, simple to compound. Flowers alternate; pedicels 1–6 mm long; bibracteolate; floral tubes 7–14 mm long, spur obtuse, horizontal to deflexed; outer surface greenish to purplish, indumentum strigose and hirsute, or only strigose; petals pink to white, unequal, the 2 dorsal petals generally wider than the 4 ventral; stamens free in the upper third of the floral tube, exserted to subexserted; vesicles present; ovules 8–18; nectariferous gland horizontal to deflexed. Seeds 2–12, 2–2.4 × 1.5–1.9 mm, obovate to elliptic, apex truncate, caruncle present, margin thinned, outline entire, surface yellowish green to dark brown, reddish macules rarely present, foveolate.

Selected material: Amaral Ferrador, estrada para a cidade, 30º44'22"S, 52º23'49"W, 21.XI.2013, fl. and fr., *M.G. Facco & C. Forgiarini 222* (ICN). Cambará do Sul, beira da estrada RS-020, entre Tainhas e a via de acesso ao Parque Nacional Aparados da Serra, 10.I.1987, fl., *D.B. Falkenberg et al. 4121* (FLOR); Parque Nacional da Serra Geral, Cânion Fortaleza, 29º04'02"S, 49º57'45"W, 7.I.2014, fl. and fr., *M.G. Facco et al. 262* (ICN). Canela, RS-466, 29º20'40"S, 50º50'42"W, 14.II.2012, fl. and fr., *M.G. Facco et al. 79* (ICN). General Câmara, distrito de Santo Amaro, 29º54'58"S, 51º52'51"W, 7.II.2014, fl. and fr., *M.G. Facco & K.A. Freitas 327* (FURB, ICN). Maquiné, Reserva Biológica da Serra Geral, 25.I.2005, fl. and fr., *R. Schmidt 857* (HAS). Pinhal Grande, Santa Vitória, 29º15'24"S, 53º23'50"W, 10.II.2013, fl. and fr., *M.G. Facco 208* (FLOR, ICN, MBM). São Francisco de Paula, RS-020, 29º22'29"S, 50º25'36"W, 15.II.2012, fl. and fr., *M.G. Facco et al. 86* (ICN); RS-484, estrada para o Pró-Mata, 29º23'35"S, 50º24'59"W, 6.I.2014, fl. and fr., *M.G. Facco et al. 256* (ICN). São José dos Ausentes, RS-020, 28º49'42"S, 50º00'02"W, 16.II.2012, fl. and fr., *M.G. Facco et al. 106* (ICN).

Cuphea urbaniana occurs in Uruguay and in the southern region of Brazil (Lourteig 1969; Cavalcanti *et al.* 2022b). In Rio Grande do Sul (Fig. 11b), it is often found in the Highland grassland and the Barba-de-bode grassland. It extends to the Andropogoneae and Composite mixed grassland and Bush grassland. Rare on the margins of the Araucaria forest. It develops in swamps and wet grasslands, rarely on riverbanks, at altitudes between 30–1,200 m. Collected with flowers and fruits from January to May and October to December.

Cuphea urbaniana, from *C.* sect. *Euandra*, is identified from others *Cuphea* species from Rio Grande do Sul by the indumentum of the stems strigose-retrorse and hirsute, vesicles present in the lower region of the stamens insertion (Fig. 4m) and by the carunculate seeds, with a thinned margin (Figs. 4n; 8k). Along the distribution, the leaves vary from narrowly elliptic to ovate, as well as the density of the indumentum.

Cuphea urbaniana was categorized as "Least Concern (LC)", according to the categories and criteria of the IUCN (2012, 2019), as it is relatively well-distributed in the state of Rio Grande do Sul.

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