


Grindelia rheophila (Asteraceae, Astereae): A new species and a river-borne exception in a genus shaped by Deserts


FERNANDO FERNANDES^{1,*}, HENRIQUE MALLMANN BÜNEKER^{1,4}, JOÃO IGANCI^{1,2,5}, TATIANA TEIXEIRA DE SOUZA-CHIES^{1,6} & GUSTAVO HEIDEN^{3,7}


¹Programa de Pós-graduação em Botânica, Instituto de Biociências, Universidade Federal do Rio Grande do Sul, Av. Bento Gonçalves, 9500, Porto Alegre, RS, Brazil

²Universidade Federal de Pelotas, Núcleo de Ilustração Científica & Laboratório de Sistemática e Evolução de Plantas; Programa de Pós-Graduação em Fisiologia Vegetal, Campus Capão do Leão, Pelotas, RS 96010-900, Brazil


³Embrapa Clima Temperado, Rodovia BR 392, km 78, Caixa Postal 403, Pelotas, RS 96010-971, Brazil

⁴✉ henriquemallmannbuneker@gmail.com;  <https://orcid.org/0000-0003-4945-5690>

⁵✉ joaoiganci@gmail.com;  <https://orcid.org/0000-0002-5740-3666>

⁶✉ tatiana.chies@ufrgs.br;  <https://orcid.org/0000-0002-1818-8748>

⁷✉ gustavo.heiden@embrapa.br;  <https://orcid.org/0000-0002-0046-6500>

*Author for correspondence: ✉ fnandes.oliveira@gmail.com;  <https://orcid.org/0000-0002-0976-7174>

Abstract

Grindelia rheophila (Asteraceae, Astereae), the first known rheophytic gumweed species is proposed, described, and illustrated here. Unlike most species of the genus, which are adapted to almost permanently dry environments, this new species thrives in dynamic riverine habitats with fast-flowing water. *Grindelia rheophila* is characterized by the erect to decumbent growth form, long linear-elliptic leaves, and a pappus with hemipaleaceous and bristle elements, which differentiate it from the morphologically similar *G. bupthalmoides*, *G. pulchella* and *G. scorzonifolia*. The new species is known only at the northern headwaters of the Ibicuí river basin along the edge of the South Brazilian plateau in the state of Rio Grande do Sul, Brazil, where it grows along rocky flood-prone margins of the watercourse, as rapids and waterfalls are influenced by seasonal hydrological fluctuations. We highlight the vulnerability of rheophile ecosystems to anthropogenic threats, particularly dam construction and climate-driven extreme weather events, justifying the recognition of the new species as Critically Endangered (CR A2ac+3c+4ac; B1a,b(i,ii,iii,iv),c(iii)). A watercolor illustration, habitat photographs, a distribution map, and an identification key for Brazilian *Grindelia* are also provided.

Key words: Compositae, endemism, Machaerantharinae, plant conservation, rheophytes, taxonomy

Introduction

Rheophilic environments are dynamic ecosystems associated with fast-flowing watercourses, where specialized plant species, known as rheophytes, develop. These plants exhibit morphological and physiological adaptations that allow them to survive in extreme conditions, such as strong currents and high-water oxygenation (Imaichi & Kato 1997; Cárdenas & Álvaro 2020; Costa *et al.* 2020). Among these adaptations, thick and narrow leaves, high stomatal density, and cuticular characteristics stand out, increasing resistance to submersion and dehydration, enabling survival in environments subject to frequent hydrological variations, such as prolonged flooding and drought periods (Costa *et al.* 2020).

Given these specialized adaptations, the conservation of rheophilic environments becomes essential for maintaining biodiversity. These ecosystems play a crucial role in stabilizing riverbanks, preserving water quality, and providing habitat for threatened endemic species (Costa *et al.* 2020). However, they are increasingly under threat due to dam construction, deforestation, and pollution, factors that compromise genetic diversity and may lead to the extinction of natural populations (Mitsui *et al.* 2008; Philbrick *et al.* 2010). Moreover, many rheophytic species have a restricted geographic distribution due to their specialized ecosystem, sometimes occupying the bed of a single river, which makes them extremely vulnerable to environmental degradation, and susceptible to extinction (Hopkins 2007; Büneker *et al.* 2013; Hoyos-Gómez & Bernal 2018).

The middle course of the Toropi river is located on the edge of the Southern Brazilian plateau within the municipalities of São Martinho da Serra, Quevedos, and Júlio de Castilhos, in the state of Rio Grande do Sul, and belongs to the Ibicuí river basin. This region lies along the southern limits of the Brazilian Atlantic Forest, dominated by inland seasonal forests of the Parana Forest province, within the Paraná Domain (Morrone *et al.* 2022), and in close contact with the grasslands and savannas along the northern limit of the Uruguayan district (Cabrera & Willink 1973) of the Pampean province in the Chaco Domain (Morrone *et al.* 2022). This contact and admixture transition zone represents an ecological mosaic characteristic of subtropical Brazil. According to Marchiori *et al.* (2014), this remote area harbors a floristic diversity that includes many endemic, rare, and threatened species. The interaction between fluvial dynamics and local geomorphology results in a range of environments. In open grassland areas, rocky or litholic soils predominate, originating from basaltic and sandstone outcrops. These soils are generally shallow and well-drained, favoring plant communities adapted to low water availability. In contrast, along the margins of the Toropi and Guassupi rivers, flood-prone environments prevail, where vegetation adapts to fluctuations in water levels and sediment deposition (Marchiori *et al.* 2014).

Building upon this complex environmental framework, the region also stands out for the impressive diversity of endemic, rare, and threatened species that reinforce its ecological and biogeographic value (Marchiori *et al.* 2014; Büneker & Witeck-Neto 2016). Numerous studies indicate that this ecological mosaic harbors organisms of great taxonomic and conservation importance, many of them endemic or restricted to very specific habitats with new species continuously being described (Iganci *et al.* 2011). The adaptive diversity of the local flora highlights the presence of species with highly specialized ecological niches. Among these are rheophytic and saxicolous species, such as *Dyckia strehliana* Büneker & Pontes in Büneker *et al.* (2013: 285) of Bromeliaceae, as they establish themselves along rocky riverbanks with fast-flowing water. On cliffs and rocky slopes of the riverbanks, *Hippeastrum multiflorum* Büneker, K. Soares & L.C. Assis in Büneker *et al.* (2018: 35) of Amaryllidaceae, *Tillandsia toropiensis* Rauh (1984: 10) and *Dyckia pseudodelicata* Büneker & Mariath (2022: 60) of Bromeliaceae, *Tradescantia multibracteata* M.D. Ferrarese, Büneker & Canto-Dorow in Büneker *et al.* (2017: 90) of Commelinaceae, *Petunia toropiensis* Stehmann & Larocca (2023: 2) of Solanaceae have been recorded. Other taxa that underscore the area's endemism and richness include *Buddleja bordignonii* Coelho & Miotto (2017: 968) of Buddlejaceae, *Butia witeckii* Soares & Longhi (2011: 204) of Arecaceae, *Glandularia rupestris* Thode & Bordignon (2019: 40) of Verbenaceae, *Mimosa cerifera* Schmidt-Silveira & Miotto in Silveira *et al.* (2019: 133) of Fabaceae, and *Rhamnidium riograndense* Figueira in Figueira & Schindler (2021: 54) of Rhamnaceae. Another notable example is *Glechhon villosissima* Laura Luz & Bordignon in Luz *et al.* (2025: 269) of Lamiaceae, which also occurs in the region in addition to a single extra record for the municipality of Vacaria, in the northeastern part of the state, where it has not been found again in recent field expeditions (Luz *et al.* 2025).

The co-occurrence of these species, both regionally endemic and sharing habitats, strongly indicates that the ecosystem of the Toropi and Guassupi river basins should be designated as a biodiversity endemism area. This rich floristic wealth not only points out to the importance of this region for further taxonomic and ecological exploration but also paves the way for future discoveries, revealing a vast potential for species not yet documented that need to be protected.

Grindelia Willdenow (1807: 259) (Asteraceae) is a predominantly xerophilous genus with a disjunct amphitropical distribution, comprising about 71 native American species, with 41 in North America and 30 in South America (Bartoli & Tortosa 1999, 2012; Fernandes 2025). In South America, the genus is represented in Peru, Bolivia, Chile, Paraguay, Brazil, Argentina and Uruguay (Bartoli & Tortosa 1999). The first comprehensive review for this region was conducted by Cabrera (1931), who recognized 11 species, a number later revised by various studies. Bartoli & Tortosa (1999) recognized 25 species and one variety, and subsequent taxonomic updates raised the total to 30 species and five varieties (Bartoli & Tortosa 2003; Deble & Oliveira-Deble 2010; Bartoli *et al.* 2012; Bartoli & Tortosa 2014; Deble & Sabatino 2022; Sabatino & Deble 2022; Fernandes 2025). In Brazil, the genus comprises seven species, all restricted to Rio Grande do Sul, three of them endemic to the state, occurring in grasslands, rocky outcrops, and psammophilous vegetation of the Pampa (Fernandes 2025).

During fieldwork on the rocky margins and fast-flowing rapids of the Toropi River, a striking population of *Grindelia* was found. The plants were discovered along the flood-prone riverbanks, thriving in the dynamic rheophilic environment. The collected specimens were analyzed as part of the ongoing taxonomic review of *Grindelia* in Brazil, leading to the identification of a new species, which is described herein.

Materials and methods

The morphological description was based on vegetative and reproductive material from herbarium specimens and living plants. A stereomicroscope Leica M165 C was used for measurements with a digital caliper. Vegetative structures were described from dried material, while reproductive structures were analyzed based on living material or after rehydration by immersing them in warm water for one minute. The indumentum and textures were observed through photographic analysis based on living and dried material. The general terminology for morphological features, measurements, and color terms follows Hickey (1973) and Beentje (2016). The specialized terminology for Compositae follows Funk *et al.* (2009) and Roque & Bautista (2008). Fernandes (2025) highlighted that much of the literature on *Grindelia* misinterprets leaves, bracts, and bracteoles, referring to leaves and bracts as “lower leaves” and bracteoles as “upper leaves”. Here, we describe these structures separately, leaves (on vegetative branches), bracts (subtending the fertile branch), and bracteoles (along flowering branches), as they exhibit clear morphological differences.

Based on photographs of living specimens and type collections, the new species was illustrated using watercolor to represent one branch holding mature and immature capitula, details of leaves and bracts, bracteoles, flowers and pappus (Figure 1, Figure 2). The illustration was prepared on 100% cotton, acid free, watercolor paper by Arches®, and watercolor colored pencil by Caran D’Ache®. The illustration was post edited and scale bars were added using Adobe Photoshop 2025®.

The geographic distribution map (Figure 3) was prepared using Quantum GIS version 3.40.3 (QGIS Development Team 2015). The preliminary conservation status assessment followed the IUCN Red List Categories and Criteria (IUCN 2024), with an attempt to apply all criteria (A–E), depending on data availability, using GeoCAT (Bachman *et al.* 2011) to calculate the Extent of Occurrence (EOO) and Area of Occupancy (AOO, 2 × 2 km grid) under criterion B.

During the revision of the genus in Brazil, the following herbaria were consulted: ECT, HDCF, HUCCS, HURG, ICN, MPUC, and PEL (acronyms according to Thiers 2025, continuously updated), as well as LASALLE from Universidade La Salle, Canoas, Rio Grande do Sul, Brazil. All collections were examined in person by at least one of the authors, except for the specimen from HUCCS, which was obtained on loan, and the specimens from HDCF and LASALLE, which were consulted through photographs. Specimens collected in the field were made by researchers with the necessary permits and in compliance with the Brazilian legislation and were deposited in the ECT and ICN herbaria.

Taxonomy

Grindelia rheophila Fern.Fern. & G.Heiden, *sp. nov.* Figure 1A–G and 2A–F.

Grindelia rheophila differs from all other congeners by the combination of linear-elliptic leaves (40–142 × 4–14 mm) and the co-occurrence of 11–12 deciduous hemipaleaceous (0–3) and bristle (9–12) pappus elements (3.3–5.1 mm long).

Type:—BRAZIL. Rio Grande do Sul: Quevedos, Usina do Rio Toropi, sobre rochedos junto ao rio, 29°23’16”S 54°01’19”W, 221 m [inferred coordinates and elevation], 15 September 2007, *R.A. Wasum 4157* (holotype ECT 10031, isotype BHCB 114548; HUCCS 31755!; ICN 167643!; JOI 11252; UFP 65452).

Shrubs, saxicolous, 0.35–1 m tall, sympodial, virgate. **Stems** erect or rarely decumbent, cylindrical, vinaceous to green, with light brown bark, smooth and slightly striate, sparsely pubescent, glabrous at maturity, trichomes glandular; internodes in upper vegetative and flowering branches 5–20 mm long. **Leaves** 40–142 × 4–14 mm, alternate, light green, concolorous, sessile, entire; blade papery, linear-elliptic; base tapering; apex acute; margin serrate with uncinatate teeth, not revolute; venation pinnate; indumentum sparsely pubescent, trichomes glandular or rarely normal. **Bracts** 31–112 × 3–12 mm, alternate, light green, concolorous, sessile, entire; blade papery, linear-elliptic; base tapering; apex acute; margin serrate with uncinatate teeth, not revolute; venation pinnate; indumentum sparsely pubescent, trichomes glandular or rarely normal. **Bracteoles** 10–45 × 3–8.5 mm, alternate, light green, concolorous, sessile, entire; blade papery, linear-elliptic to oblong or lanceolate near the capitulum; base tapering; apex acute; margin serrate with uncinatate teeth, not revolute; venation pinnate; indumentum sparsely pubescent, trichomes glandular or rarely normal; as they ascend, the bracteoles become progressively smaller and more similar in appearance to the outer phyllaries. **Capitulum** solitary; *involucre* 8–10 × 9–20 mm, 4–5-seriate. **Phyllaries** 68–81. *Outer phyllaries* 7–8 × 1–1.5 mm, light

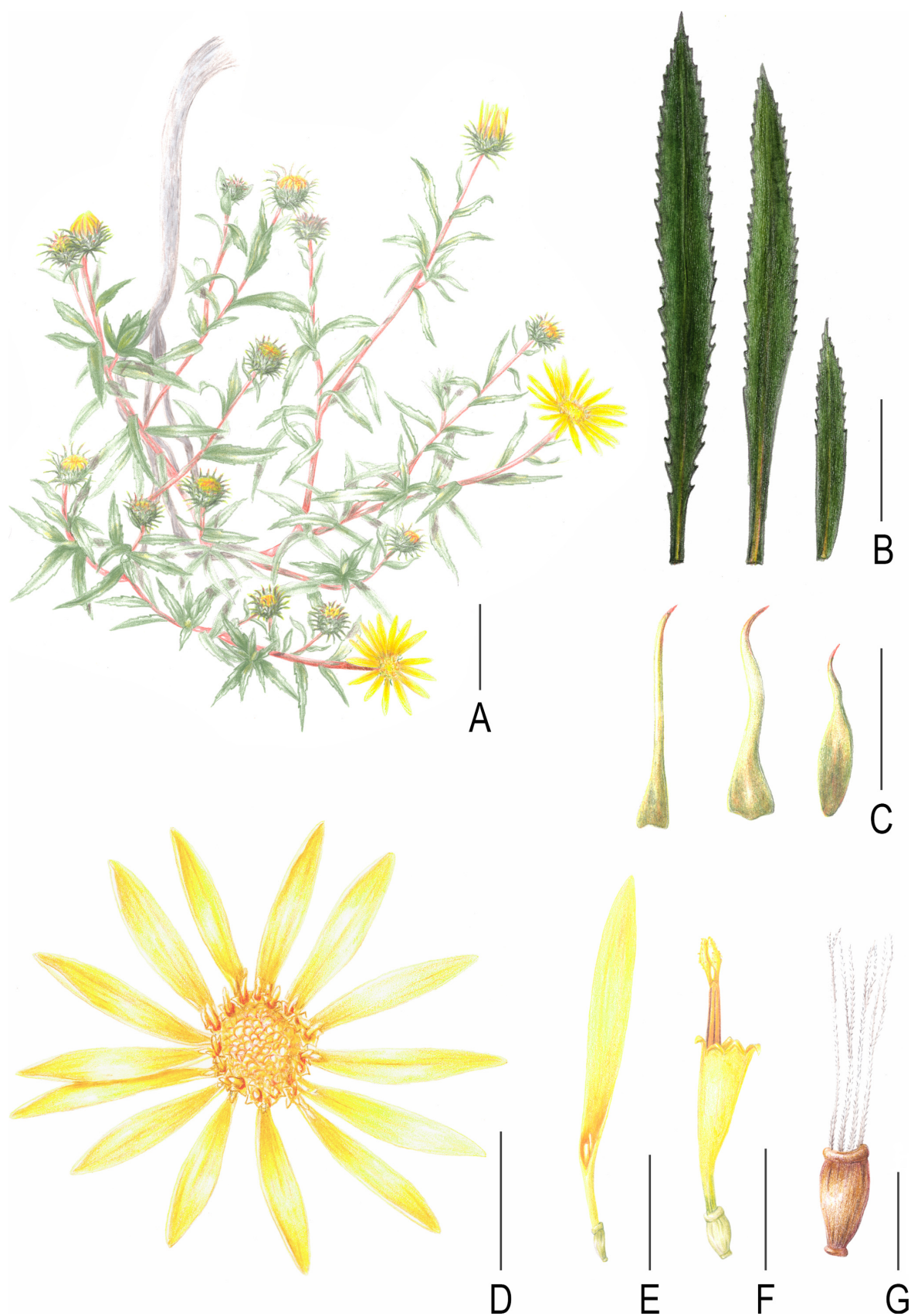


FIGURE 1. *Grindelia rheophila* (Asteraceae, Astereae). **A.** Habit showing the decumbent growth form influenced by past water flow (scale bar = 13 cm). **B.** Vegetative leaf, bract, and bracteole, adaxial view from left to right (scale bar = 3 mm). **C.** Outer, median, and inner phyllaries from left to right (scale bar = 7 mm). **D.** Capitulum in front view (scale bar 2 cm). **E.** Ray floret (scale bar = 1 cm). **F.** Disc floret (scale bar = 5 mm). **G.** Cypsela and pappus (scale bar = 2 mm). A (*Bordignon s.n.*, LASALLE), B, D, E, F (*Büneker 98*, ECT), C, G (*Wasum 4157*, ICN). Illustration by João Iganci.

green and sometimes vinaceous at the apex, linear-lanceolate, papery; base decurrent, adpressed; midportion patent; apex long attenuated, supinate; margin smooth; indumentum sparsely pubescent with glandular trichomes. *Second series* 7–8 × 1.1–2.0 mm, light green and sometimes vinaceous at the apex, linear-lanceolate, papery; base decurrent, adpressed; midportion patent; apex long attenuated, supinate; margin smooth; indumentum sparsely pubescent with glandular trichomes. *Intermediate series* 7–8 × 1.5–2.1 mm, light green to light green and stramineous on the margins, sometimes vinaceous at the apex, lanceolate, papery; base decurrent, adpressed; midportion patent; apex long attenuated to attenuate, supinate; margin smooth; indumentum sparsely pubescent with glandular trichomes. *Inner phyllaries* 6–9 × 1.7–2 mm, light green to stramineous on the margins, lanceolate to elliptic, papery; base decurrent, adpressed; apex attenuated; margin smooth; indumentum sparsely pubescent with glandular trichomes. **Receptacle** slightly convex. **Ray florets** 15–24, pistillate, ligulate, corolla yellow; tube 4–6.1 × 0.4–0.8 mm, sparsely pubescent with glandular trichomes; throat puberulous with glandular trichomes; limb elliptic, 14–25 × 3–3.2 mm; apex acute; puberulent to glabrous, trichomes glandular when present. *Ovary* ovoid to ovoid-cylindrical, 1.6–1.9 × 0.9–1.1 mm; puberulent to glabrous, trichomes glandular when present. *Style* 3.8–8 mm long; *style arms* 0.4–1 mm long, apex sparsely pubescent. **Disc florets** 128–211, perfect; corolla yellow; tube 5.3–7.3 × 1–1.7 mm, sparsely pubescent with glandular trichomes, when present; throat puberulous with glandular trichomes, when present; *lobes* puberulent to glabrous, glandular trichomes when present. *Anthers* 2.3–4.3 mm long, light yellow. *Ovary* 1.1–1.9 × 0.6–1.2 mm, ovoid to cylindrical; sparsely pubescent to glabrous, trichomes glandular when present; *style* 5.4–10.9 mm long; *style arms* 1.8–2 mm long, apex sparsely pubescent. **Cypselae** 2–3 × 1–1.2 mm, brown, laterally flattened, glabrous, apex truncate. *Pappus* hemipaleaceous, 3.3–5.1 mm long, 11–12 pappus elements; 0–3 scale; 9–12 bristles, deciduous.

Distribution and Habitat:—Localities of *G. rheophila* were found in the municipalities of Jari, Júlio de Castilhos, Quevedos and São Martinho da Serra, in Rio Grande do Sul state, Southern Brazil (Figure 3). The new species is saxicolous and grows along the edge of the South Brazilian plateau in the northern headquarters of the Ibicuí river basin tributaries at an elevation of approximately 219 to 401 meters above sea level. Two populations are found along the bedrock margins of the rapids of the Toropi river, which marks the natural border between the municipalities of Jari, Júlio de Castilhos and Quevedos, while the second record comes from Cachoeira do Moinho, a waterfall of the Itaimbé creek, which is a tributary of the Ibicuí-Mirim river in São Martinho da Serra municipality. *Grindelia rheophila* is always associated with rheophilic environments in the river's flood-prone margins (Figure 3). It occurs together with other typically rheophytic species endemic to the area, often growing among populations of *Dyckia strehliana* (Bromeliaceae).

Preliminary Conservation Status:—*Grindelia rheophila* is classified as Critically Endangered (CR) following the IUCN (2024) Red List assessment criteria: A2ac+3c+4ac; B1ab(i,ii,iii,iv)c(iii). This classification is based on the species' extremely limited geographic distribution, with an Extent of Occurrence (EOO) of 43.8 km² and an Area of Occupancy (AOO) of 16 km², calculated from the actual area where individuals were observed. These spatial metrics were obtained through analysis using GeoCAT (Bachman *et al.* 2011), which showed the species occurs in a highly fragmented and degraded habitat. All applicable IUCN criteria (A–D) were evaluated; criterion E was not applied due to insufficient data for quantitative extinction risk analysis.

The species is known from only three isolated populations. Its largest population, in the Toropi River, is under a strong influence from a dam (PCH Quebra Dentes), located approximately 110 meters away, which compromises habitat quality. Additionally, recent and future floods, intensified by climate change, have the potential to decimate these already fragile populations (Garssen *et al.* 2015, 2017). The species has a reduced EOO, and its AOO is only 6 km² above the threshold that would also classify it as Critically Endangered (CR) under criterion B2 a,b(i,ii,iii,iv),c(iii), indicating that this parameter is already at the maximum risk threshold before extinction.

Grindelia rheophila exhibits typical adaptations of rheophytes, with its growth form and leaves shaped by hydrodynamics being the main characteristics (Imaichi & Kato 1997). The species was found exclusively in these environments, highlighting its vulnerability to disturbances in water regimes and the pressures from human activities and climate change.

The Toropi river and the Itaimbé creek are tributaries of the Ibicuí river, which was affected by the extreme weather event that occurred in Rio Grande do Sul state in May 2024, which caused unprecedented social and ecological damage across Rio Grande do Sul, impacting 95% of the state's municipalities (Pillar & Overbeck 2024). Although the most severe impacts were recorded in the Taquari-Antas and Jacuí basins, flooding also disrupted ecosystems along the Toropi River and other watercourses (Rio Grande do Sul 2024). Such extreme events, which are becoming increasingly frequent, pose a threat to riparian environments and may endanger plant species that grow in these habitats, such as *G. rheophila*. Given the increasing frequency of such extreme weather events, the conservation of *G. rheophila* requires urgent attention, including enhanced habitat protection, continuous monitoring of population dynamics in the face of climate change and seed collection for *ex situ* conservation.

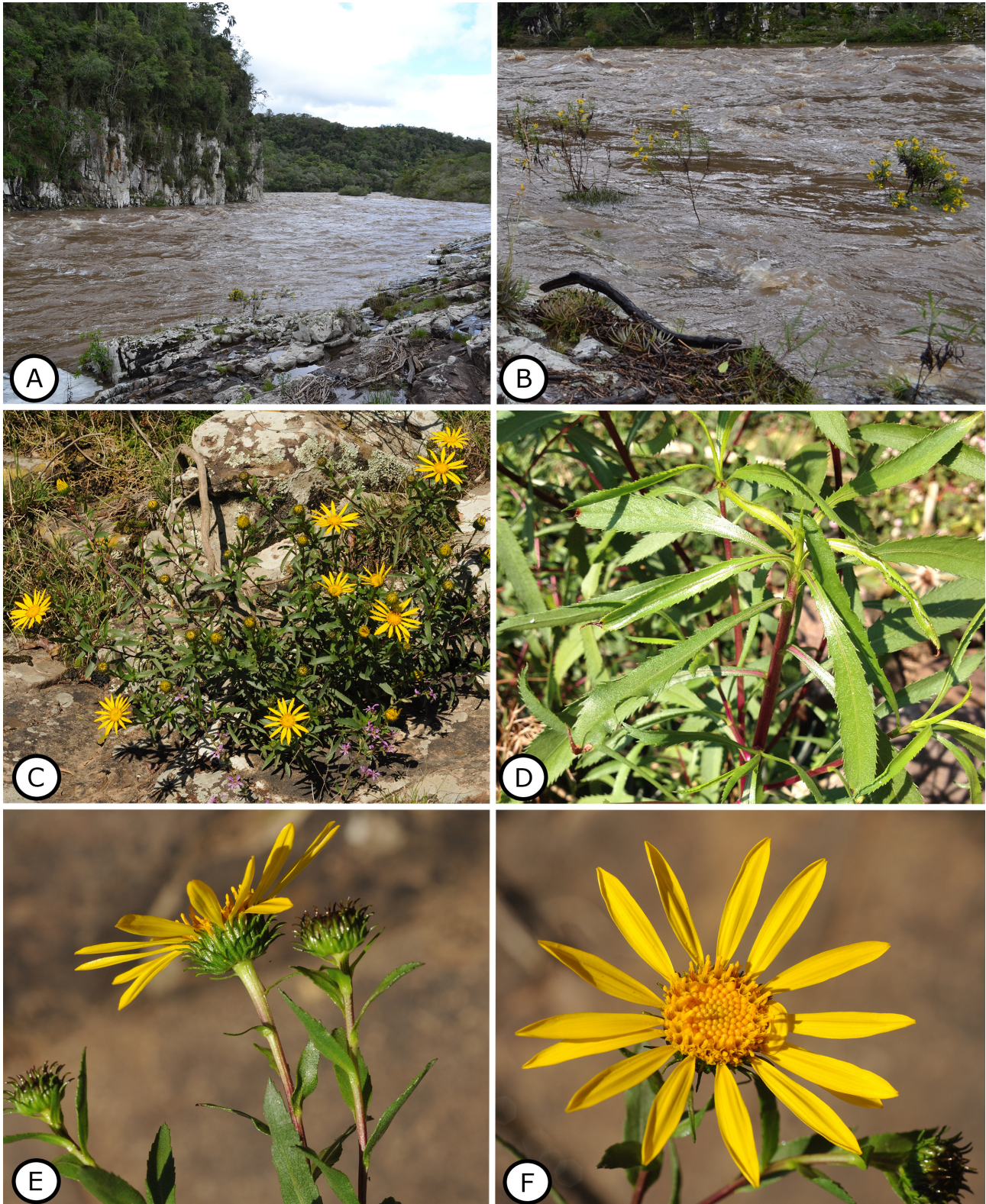


FIGURE 2. *Grindelia rheophila* (Asteraceae, Astereae). **A.** Habitat along the rocky margins of the Toropi River, Júlio de Castilhos and Quevedos municipalities border, Rio Grande do Sul, Brazil. **B.** Habit view during a flooding, with the species persisting despite the strong stream. **C.** Habit in a dry flood-prone margin, showing the decumbent growth form influenced by past water flow at Jari, Rio Grande do Sul, Brazil. **D.** Vegetative leaves. **E.** Lateral view of the capitulum and buds. **F.** Capitulum in front view. Pictures by H.Büneker (A, B, D); S.Bordignon. (C, E, F).

Previous research in the region (Marchiori *et al.* 2014) provided recommendations during the licensing process of the Quebra Dentes Hydroelectric Power Plant, which were successfully implemented. Following these suggestions, an area with a palm grove of the endangered *Butia witeckii* and *Trithrinax brasiliensis* Martius (1844: 44) located

near the project was transformed into a conservation area, ensuring protection for the native species occurring there. However, changes in the hydrological regime caused by upstream damming may still be negatively affecting rheophytic communities contiguous to the conservation area, where the *G. rheophila* populations are found.

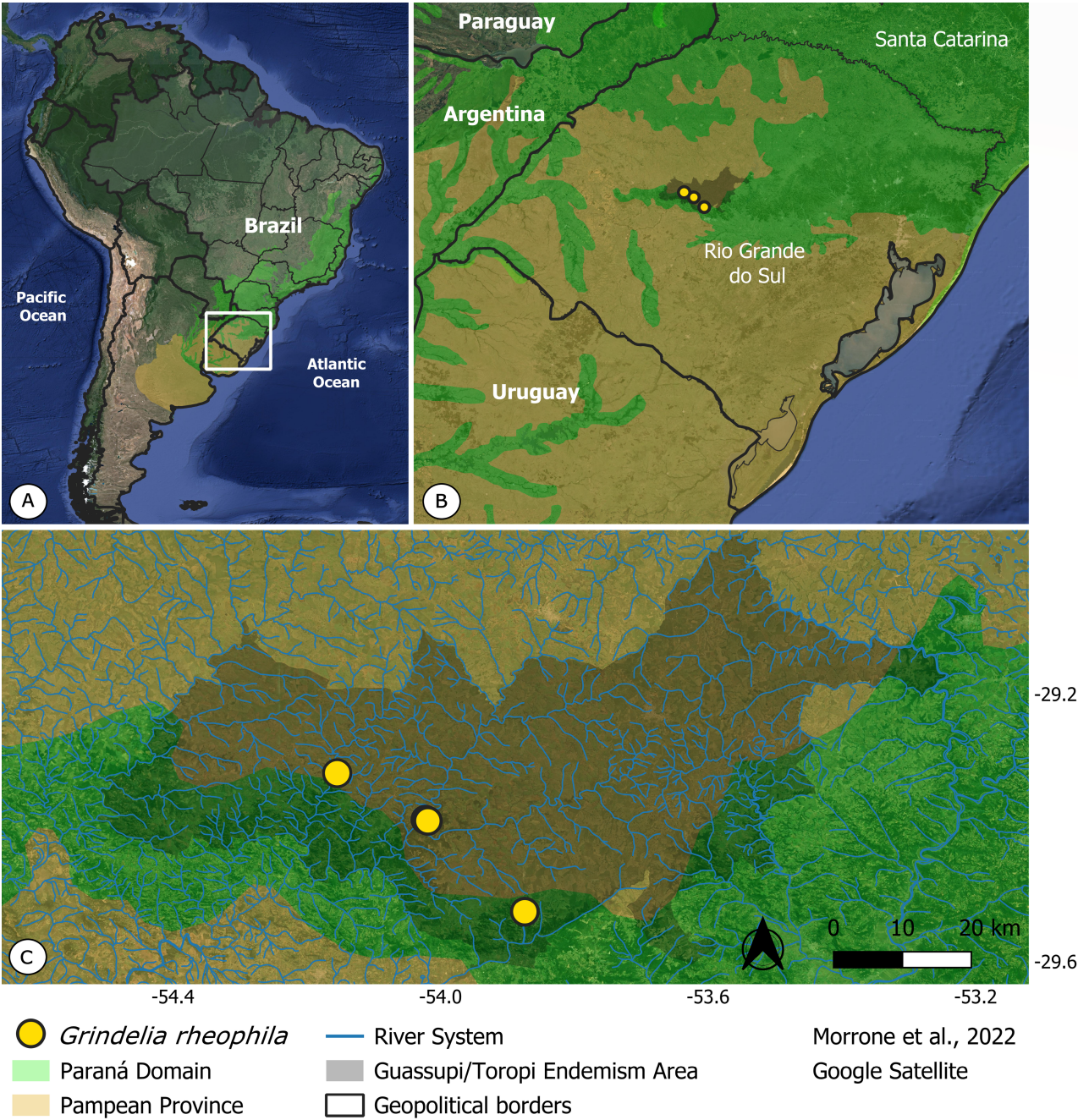


FIGURE 3. Occurrence map of *Grindelia rheophila* (Asteraceae: Astereae). **A.** South America, highlighting in red the region where the Paraná Domain meets the Pampean Province in southern Brazil (Morrone *et al.* 2022). **B.** Ecotone region in the state of Rio Grande do Sul, Brazil, where the Guassupi/Toropi rivers center of endemism is shaded and the species known occurrences are mapped. **C.** Specific occurrence sites in the ecotone region, associated with the river systems of the area. Map by F. Fernandes.

Etymology:—The specific epithet refers to the rheophilic habitat of the new species and the morphological adaptations specialized for this environment.

Phenology:—Flowering specimens were collected in nature from September and October. Under cultivation in the rocky garden of the Colégio Politécnico of the Federal University of Santa Maria, two specimens of *G. rheophila* produced their first buds in August and flowered up to June.

Notes:—The new species was assigned to *Grindelia* because it exhibits all the diagnostic traits of the genus described by Nesom & Robinson (2007), such as glutinous leaves, capitula with campanulate involucre, bracts arranged in multiple series (4–5) with sclerified bases, thick-walled cypselae, and a pappus composed of few deciduous

elements (11–12). *Grindelia rheophila* was previously identified as *G. scorzonifolia* Hooker & Arnott (1836: 45) or *G. buphthalmoides* Candolle (1836: 16). However, *G. buphthalmoides* has oblanceolate leaves (vs. linear-elliptic) and only bristle pappus elements (vs. bristles and some hemipaleaceous ones). On the other hand, *G. scorzonifolia* is a prostrate or decumbent shrub (vs. erect, sometimes decumbent), with narrowly elliptical leaves that are lobed, pinnatifid, or pinnatisect (vs. entire linear-elliptic), and has 4–7 pappus bristles (vs. 11–12 elements, including some hemipaleaceous ones). The new species also superficially resembles *G. pulchella* Dunal (1819: 51), which also has linear-elliptic leaves, but differs by its smaller leaf size (23–51 × 2–4 mm vs. 40–110 × 4–13 mm) and by having only 6–9 bristly pappus elements (vs. bristles and some hemipaleaceous ones).

Additional specimens examined (paratypes):—BRAZIL. **Rio Grande do Sul: Jari**, Estrada para Quevedos, campo pedregoso nas margens do rio Toropi; decomposição de basalto, 12 September 2002, *S. Bordignon s.n.* (UNILASALLE 2308). **Júlio de Castilhos & Quevedos**, saxícola em ambas as margens do rio Toropi, próximo à antiga Usina de Quebra Dentes, 29°23'23.1"S, 54°01'07.8"W, seedling obtained on 19 September 2012, flowering and herborized on 24 August 2016 from specimen cultivated in Santa Maria, *H.M. Büneker 98, R.C. Pontes & L. Witeck* (ECT!, ICN!). **São Martinho da Serra**, 1 m de altura, capítulos de cor amarela, em paredão ao lado da Cachoeira do Moinho, 18 de outubro de 2015, 29°31'32"S, 53°52'26"W, *L. Lemer & G.A. Orso 41* (HDCF 7364 digital image!).

Key to identifying the species of *Grindelia* from Brazil

1. Shrubs prostrate, radicans *G. atlantica*
- Shrubs virgate or decumbent or prostrate, not radicans 2
2. Leaves linear-elliptical 3
- Leaves oblong, oblanceolate or narrowly elliptical 4
3. Leaves 40–142 × 4–14 mm. Pappus hemipaleaceous, with scales and bristles *G. rheophila*
- Leaves 23–51 × 2–4 mm. Pappus of bristles *G. pulchella*
4. Shrubs virgate 5
- Shrubs decumbent or prostrate 6
5. Cypselae 4.7–6 mm long, pappus elements 21–24 *G. buphthalmoides*
- Cypselae 3–4 mm long, pappus elements 13–17 *G. gaucha*
6. Leaves with petioles, blade narrowly elliptical, lobed, pinnatifid or pinnatisect *G. scorzonifolia*
- Leaves sessile, blade narrowly oblong to oblong, entire *G. puberula*

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