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CAPITULUM

THE INTERNATIONAL COMPOSITAE ALLIANCE NEWSLETTER

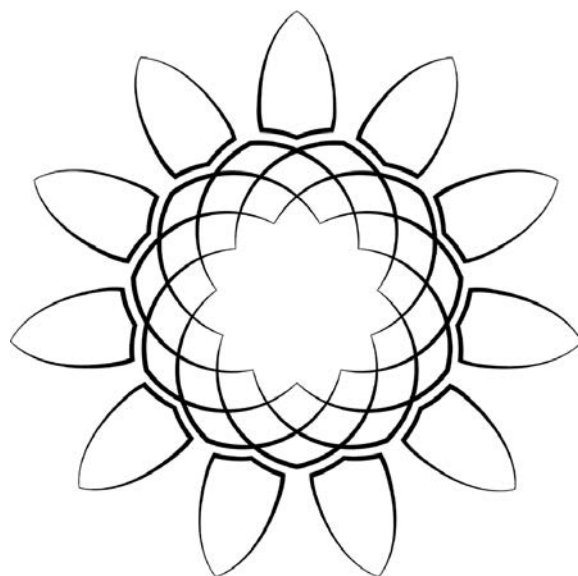


 **TICA**
THE INTERNATIONAL COMPOSITAE ALLIANCE

VOLUME 1(1)- JULY 2021

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CAPITULUM is the Newsletter of The International Compositae Alliance and is meant to be a venue for all things Compositae and welcomes all kinds of diversity in both its contributions and contributors. ISSN 2789-2786.

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A NOTE FROM THE EDITORIAL BOARD

on the new series of the TICA Newsletter

Thank you for joining us for the first issue and reboot of the Compositae Newsletter, *Capitulum*. The Compositae Newsletter was started by Tod Stuessy and Robert M. King in 1975, and had several headquarters throughout the years. Tod Stuessy, then based at the Ohio State University, served as editor to the first five issues and then George Jeffrey from The Royal Botanic Gardens at Kew edited the journal through issue 12 in 1982. The torch passed then to Jette Baagoe from Denmark who would edit issue 13, which would turn out the last of that period as the newsletter was discontinued for six years. Then in 1988 Bertil Nordenstam from the Swedish Museum of Natural History took on the editorship of the newsletter for a stretch of 25 years until issue 50 in 2012.

Nine years later, in this new form to which we affixed the name of the morphological structure classically associated with the family, the spirit remains the same as that of the original newsletter; that is, to be a venue for all things Compositae and welcome all kinds of diversity in both its contributions and contributors. Our idea is to also produce two issues per year and keep contents close to the original conception with a heavier use of graphic content thanks to the fact that the newsletter will be in electronic format only.

This work has grown out of the efforts of former and new members of The International Compositae Alliance (TICA) and complements our online seminar series: TICATalks (on Twitter @TICATalks).

In this issue, check out 'Head Topics' for an in depth look at the power of teamwork from the hand of Alfonso Susanna who presents the recent advancements in their understanding of the Cardueae. Gustavo Heiden and J. Mauricio Bonifacino introduce us to the world of one of the largest remaining genera of the Compositae, *Baccharis*. Vinicius Bueno and collaborators present a synopsis of their work on Neurolaeneae. For a quick read about some of the latest happenings in our global efforts, see the 'Brevia' this issue covering the Compositae highlights in the Flora of Brazil by Paulo Gonella, Carolina Siniscalchi, and Benoit Loeuille and Compositae of Minas Gerais by Carolina Siniscalchi, Benoit Loeuille, and Nádia Roque. Next, stop on by the 'Pipet and the Press' to learn what all the hype is about HybSeq by Jennifer Mandel. Then, Erika Moore will update us on the elusive *Helianthus verticillatus*, a United States federally endangered species in 'The Handlens'. Just need some time with plants of the past? This issue's 'From the Cabinet' will introduce you to Ynés Mexía, a Mexican-American female botanist who collected more than 140,000 specimens by Phd graduate student Lizzie Roebke. Get some fresh air and see some beautiful specimens in the 'From the Field' where you will be greeted by travels in search of *Layia glandulosa* with your tour guides Isaac Lichter-Mark and Bruce Baldwin. Peruse the many beautiful and fabulous images of comps in the section, 'Style'. Finally, a recap of TICATalks and selection of some of the latest Compositae related scientific articles in 'Current Contents in Compositae'.

We hope you enjoy *Capitulum* and look forward to your feedback and future contributions to studying this most fascinating plant family. Thistle be fun!


Jennifer R. Mandel


Abigail Moore


Benoit Loeuille


J. Mauricio Bonifacino


Erika R. Moore


Lizzie Roebke

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The more the merrier:

The Cardueae Radiations Group and the power of team work.

Alfonso Susanna¹ 

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Keywords: *Jurinea*, *Saussurea*, subtribal classification, target-enrichment.

The systematics of the Cardueae Cass. has been a headache for centuries. Thistles are one of the largest tribes of the Compositae, and the diversity of forms, habits, and floral structures they hold has made it very difficult to obtain a satisfactory subtribal classification. Since Cassini's first attempts (Cassini, 1819), proposals have been many, none of them unanimously accepted: the problems were subdued, but they reappeared; a well-known story reviewed in depth by Susanna et al. (1995). The latest classification proposed by Susanna & Garcia-Jacas (2007, 2009) into five subtribes (Cardopatinae, Carlininae, Echinopsinae, Carduinae and Centaureinae) was still, in the authors' words, a compromise solution.

In addition to the difficulties of subtribal classification, one of the problems of the Cardueae has been the megagenera of the tribe: *Cousinia* Cass. (600 spp.), *Cirsium* Mill. (400 spp.), *Jurinea* Cass. (200 spp), *Saussurea* DC. (400 spp.) and *Centaurea* L. (250 spp.). The study of any of them is fraught with difficulties: from the sampling, which must be exhaustive, to the methodology used. Our previous experiences of analyzing large genera with traditional sequencing (*Cousinia*, cf. López-Vinyallonga et al. 2009; *Centaurea*, cf. Hilpold et al., 2014) had been disappointing. Mandel's work fine-tuning the target-enrichment method for Compositae (Mandel et al., 2014) made us think that we finally had a tool capable of tackling studies that until now seemed utopian. We needed a better tool, and the target-enrichment sequencing methodology seemed a great opportunity to us.

In view of the arrival of better and very promising methods, from the Botanical Institute of Barcelona we decided in 2017 to undertake the study of two of the greatest radiations of the tribe: the genera *Saussurea* and *Jurinea*, a poorly known and worse defined group with a spectacular radiation in the mountains of East Asia. The first challenge was sampling. Most of the *Saussurea* species are found in the Qinghai-Tibetan Plateau, the Himalayas and especially in the Hengduan Mountains. *Jurinea* species, on the other hand, are located somewhat more to the northwest, in the Tian Shan, with secondary nuclei in the Caucasus and the Irano-Turanian plateau. Altogether, it is an immense region, difficult to access and that poses logistical problems that cannot be solved in the four-year course of a research project. This is the basic point of this article: the creation of an international working group to solve the problem of sampling. The Cardueae Radiations group was born, made up of scientists from China, Korea, France, Iran, Japan, Russia, Spain, and the USA. The group was formed by researchers specialized in the genera of study from all regions, with the main goal of achieving a large sample; and a second goal: each participant in their area would contribute taxonomic knowledge of the species that would be included in the project.

The first step of the project consisted in verifying that the target-enrichment technique offered us the results we expected. Mandel (2014) had already shown that the probes designed for the Compositae gave results in the Cardueae but on a minimal

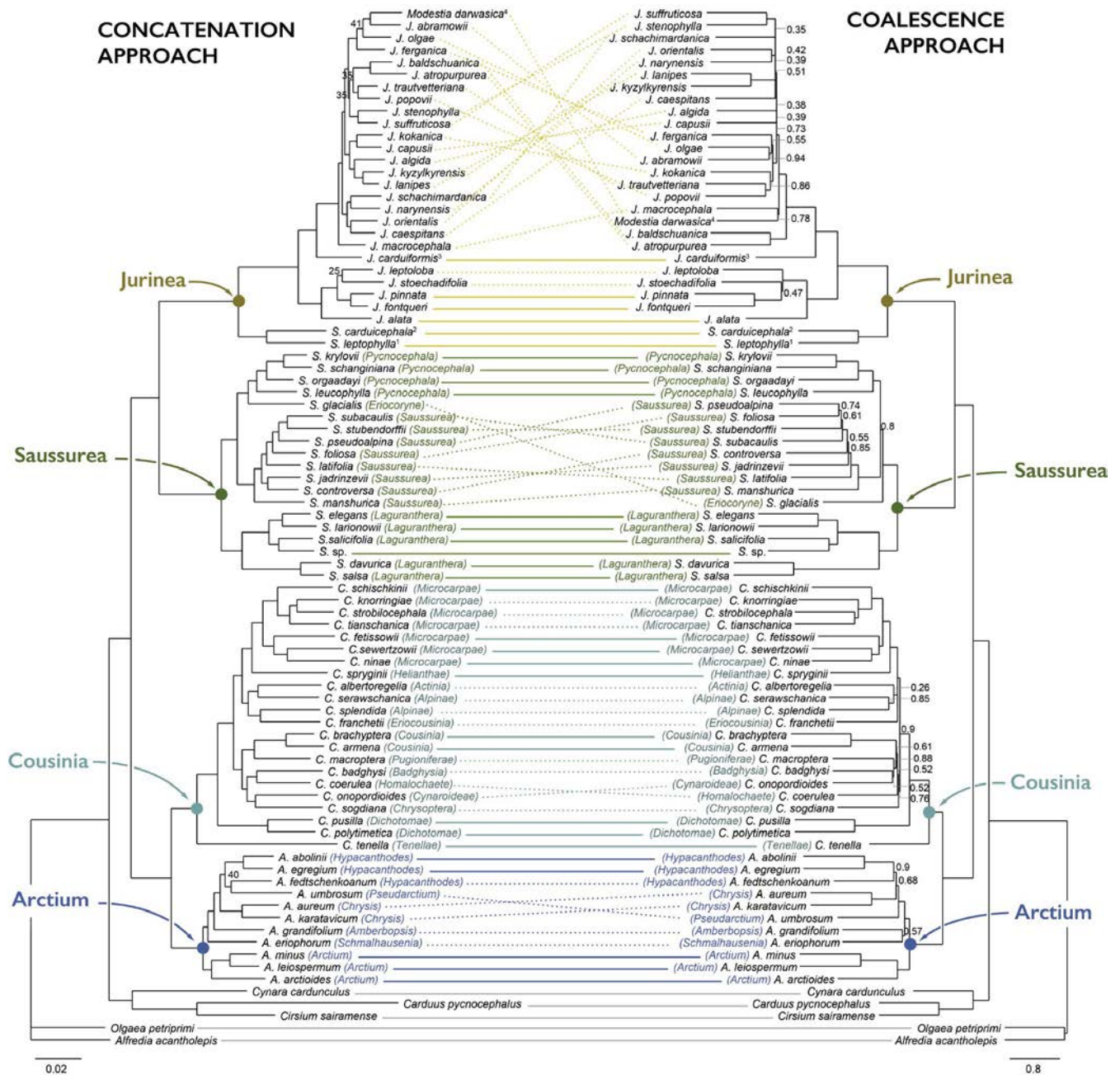


Figure 1. Phylogenetic trees inferred from the concatenation approach and the coalescence approaches, on a sample of the largest three genera of tribe Cardueae. Continuous lines linking the species represent congruent positions between both trees, dashed lines represent incongruent positions. Sections are indicated between brackets for each species. From Herrando-Moraira et al. (2018).

sample. We designed a sample that included species of the radiations targeted by the project. The result of this study (Herrando-Moraira et al., 2018) showed that the technique worked; the results were promising. We also took advantage of the preliminary study to fine-tune the technique and test different data processing methods (pipelines) and analysis methods (coalescence and concatenation;

Figure 1). After this success and after verifying that the technique worked, the next step was to try to solve two problems prior to the specific studies of *Jurinea* and *Saussurea*.

One of the problems was the classification of *Jurinea* and *Saussurea* in their own subtribe. The possibility of defining a new subtribe *Saussureinae*

was informally suggested by Susanna & Garcia-Jacas (2007, 2009) but inconsistencies in the molecular results resulted in an entanglement of *Jurinea*, *Saussurea* and *Cousinia* (Susanna et al., 2006; Barres et al., 2013). Thereafter, we gathered a sample of 140 species that represented all the taxonomic groups defined in the Cardueae, both the formal ones (the five classical subtribes) plus the informal groups of Susanna & Garcia-Jacas (2009). This work was a complete success and we finally obtained a natural classification of the tribe, a classification that matched exactly what could be deduced from the morphology (Herrando-Moraira et al., 2019).

The proposed classification (Figure 2; Figure 3) can be considered revolutionary and we have gone from recognizing five sub-tribes to recognizing twelve, six of them new: Carlininae, Cardopatiinae, Echinopsinae, Dipterocominae (Figure 5), Xerantheminae, Berardiinae, Staehelininae, Onopordinae, Carduinae, Arctiinae, Saussureinae (Figure 6) and Centaureinae (Figure 7). An important conclusion of the study was that previous problems in classification are due to the use of plastid markers (e.g., Barres et al., 2013), and an old hybridization at the base of *Arctium-Cousinia-Saussurea-Jurinea* makes plastid and nuclear markers give contradictory results.

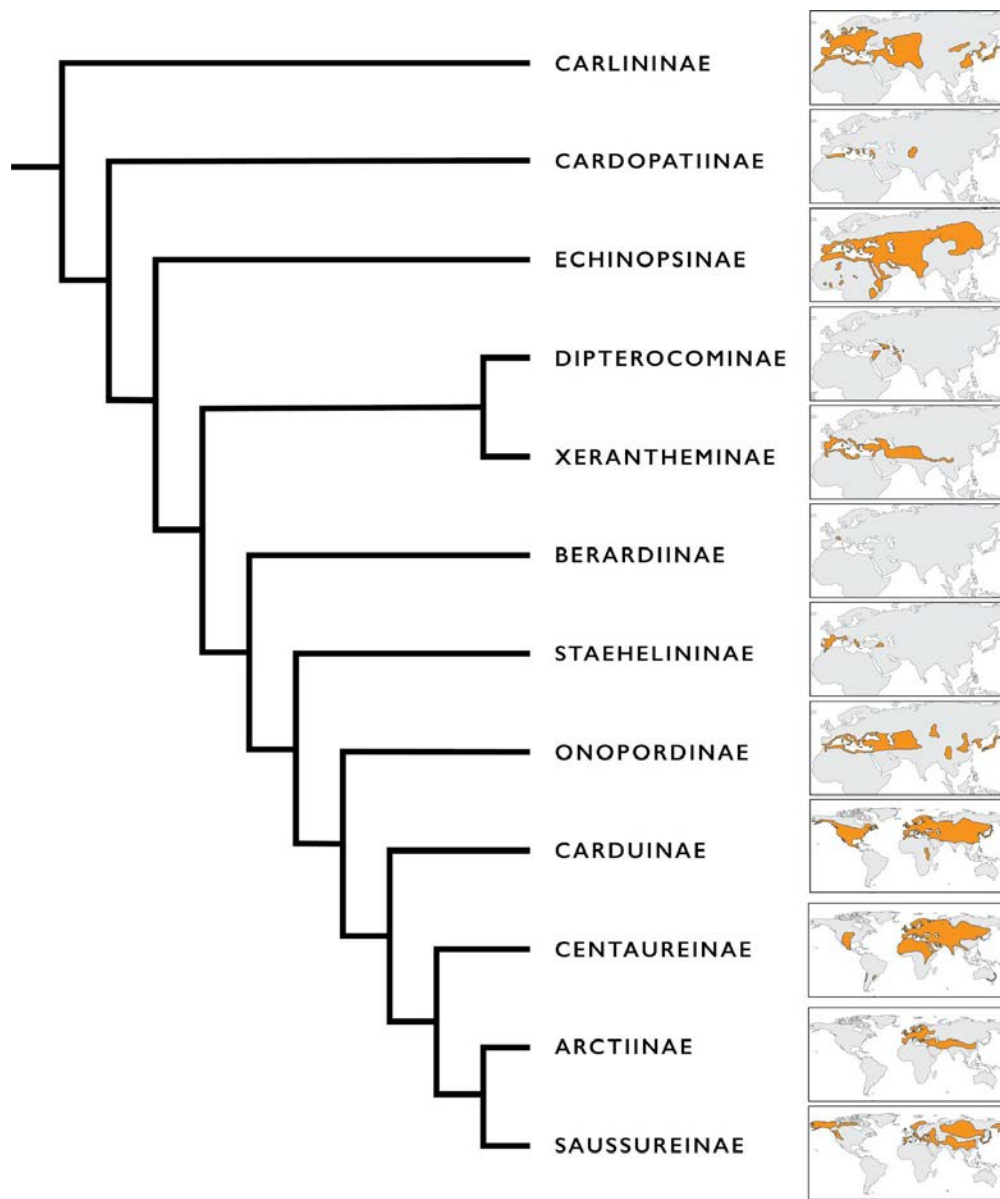


Figure 2. Condensed phylogenetic tree resulting from the analysis of Herrando-Moraira et al. (2019) showing the new classification of tribe Cardueae in twelve subtribes and their geographic distributions.

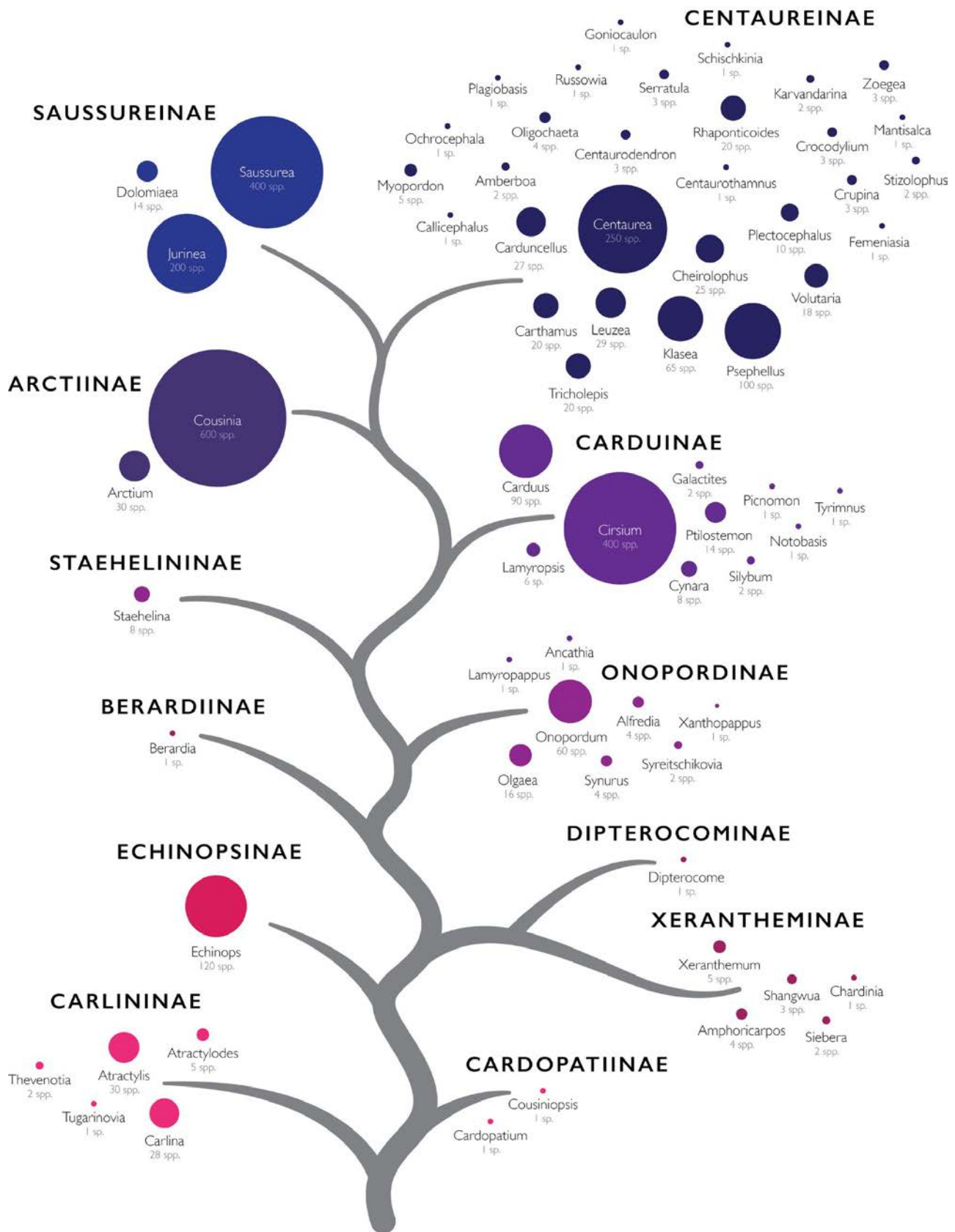


Figure 3. Diagram showing the subtribes and genera of Cardueae distributed along a tree. The size of the circles is proportional to the number of species in each genus.

Cousinia

The genus *Cousinia* Cass. comprises 600 species from the Irano-Turanian region. Its phylogeny and its classification are among the final challenges that still remain in tribe Cardueae.

Cousinia lanata C.Winkl., a poorly species from Tajikistan
Photo by Alfonso Susanna

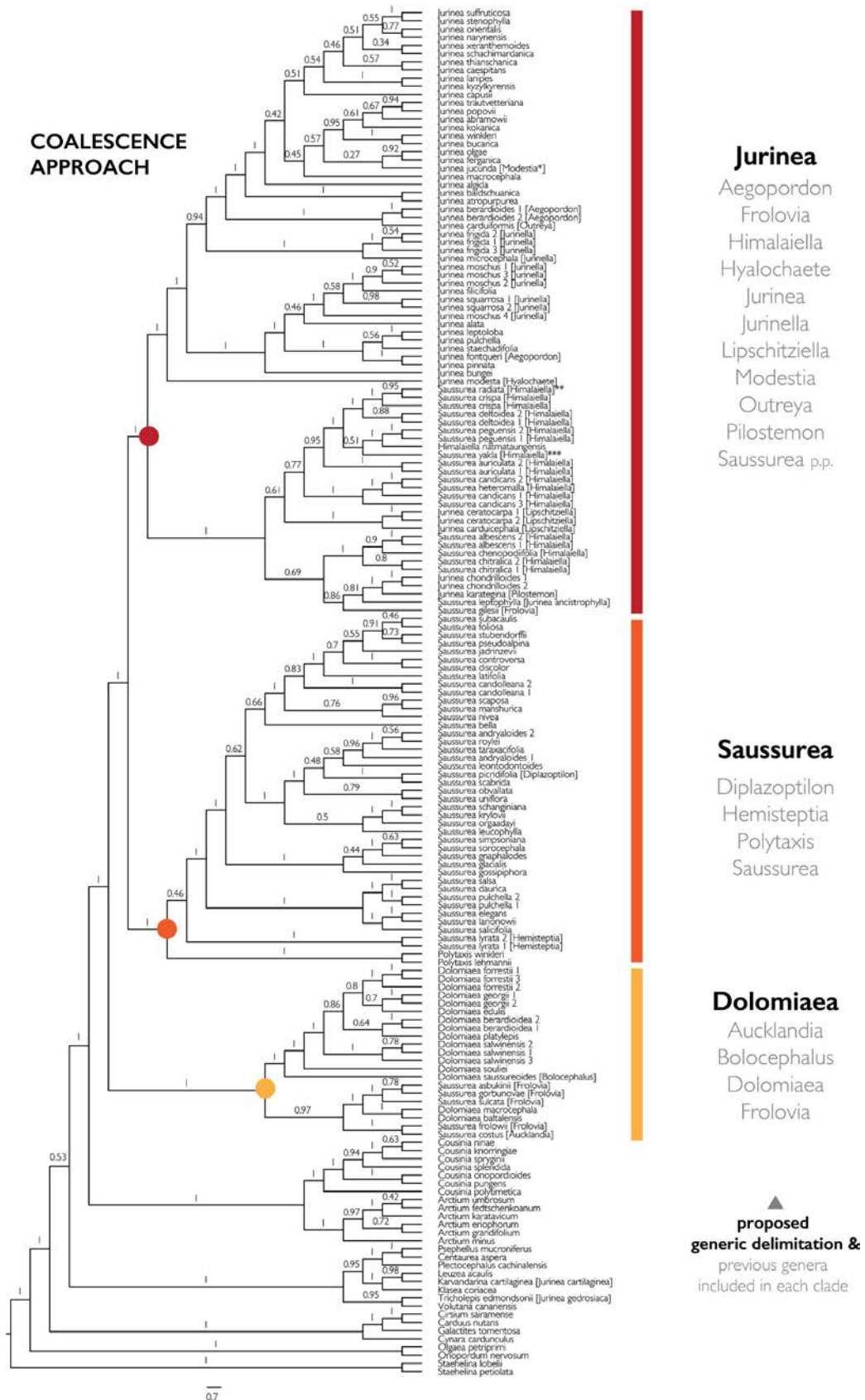


Figure 4. Phylogenetic tree of subtribe Saussureinae showing how all the genera described in the subtribe should be classified in only three. From Herrando-Moraira et al. (2020).



Figure 5. Diversity across the Cardueae. **A.** *Cardopatum corymbosum* Pers. (Cardopatiinae). **B.** *Carlina comosa* (Spreng.) Greuter (Carlininae). **C.** *Echinops spinosissimus* Freyn (Echinopsinae). **D.** *Siebera pungens* (Lam.) J.Gay ex DC. (Xerantheminae). **E.** *Dipterocone pusilla* Fisch. & C.A.Mey. (Dipterocominae). Photos: **A-D**, A. Susanna; **E**, A. Pavlenko.

The second problem (a vexing one) was posed by the generic delimitation of *Saussurea* and *Jurinea*. We could not undertake a study of a genus without knowing its exact limits, and this was not the case. To give an example of the complexity of the group, the Flora of China (Shi & Raab-Straube, 2011) recognizes 11 genera in the *Jurinea-Saussurea* complex, while Susanna & Garcia-Jacas (2009) only accepted three,

out of the ca. 20 genera described in the complex (Susanna et al., 2006). We designed a sample that for the first time gathered representatives of every small genus described in the Saussureinae and we applied the target-enrichment procedure. The result was unambiguous (Figure 4): all the variability of the Saussureinae can be packed in only three genera (Herrando-Moraira et al., 2020).



Figure 6. Diversity across the Cardueae (cont.). **A.** *Berardia subacaulis* Vill. (Berardiinae). **B.** *Synurus deltoides* (Aiton) Nakai (Onopordiinae). **C.** *Staehelina petiolata* (L.) Hilliard & B.L.Burt (Staeheliniinae). **D.** *Cynara baetica* (Spreng.) Pau (Carduinae). **E.** *Cirsium eriophorum* Scop. (Carduinae). **F.** *Arctium lappa* L. (Arctiinae). **G.** *Saussurea bracteata* Decne. (Saussureinae). Photos: **A, C.** Roquet; **B,D-E,** A. Susanna; **F.** M. Bonifacino; **G.** J. López-Pujol.

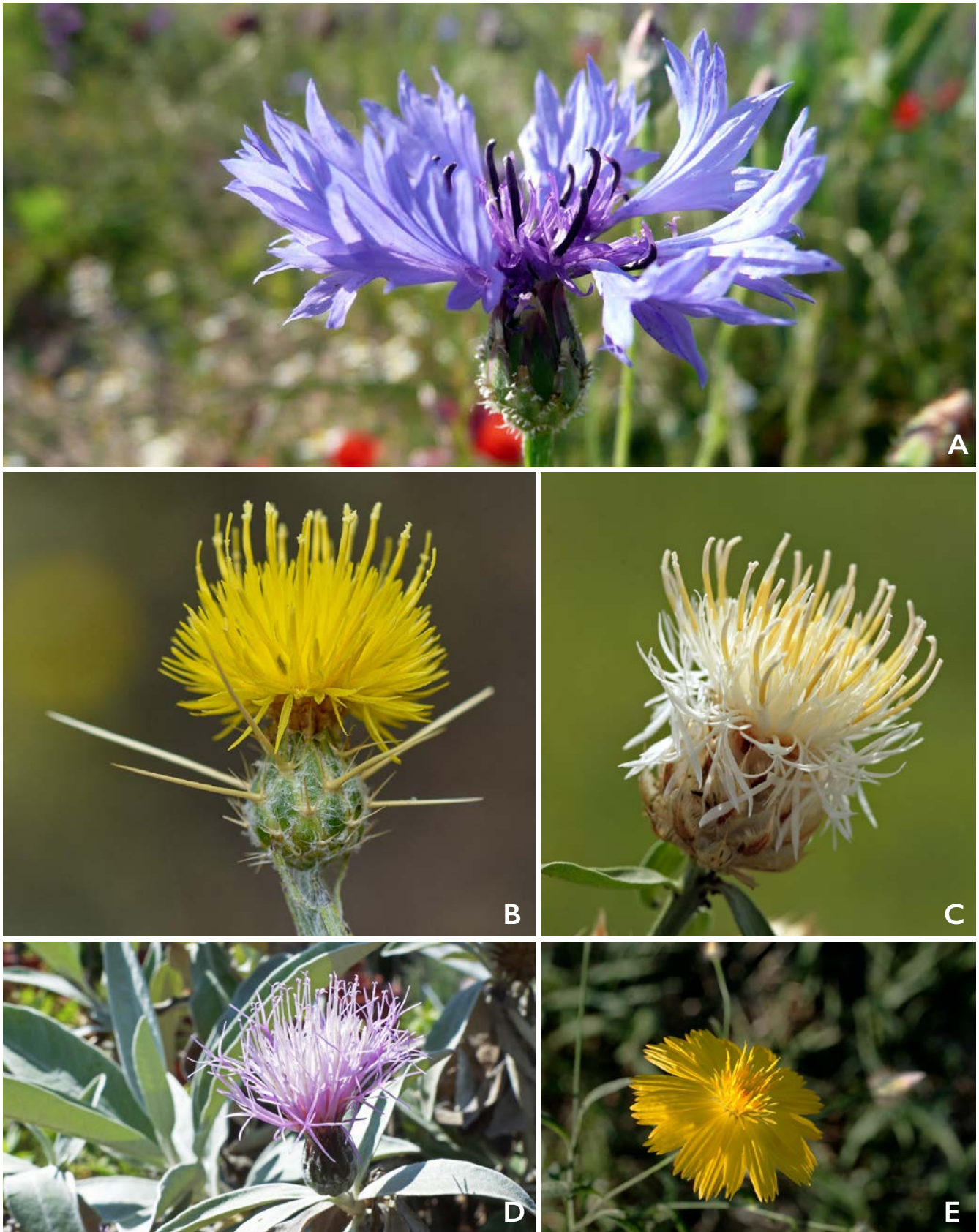


Figure 7. Diversity across the Cardueae (cont.). Centaureinae. **A.** *Centaurea cyanus* L. **B.** *Centaurea solstitialis* L. **C.** *Centaurea princeps* Boiss & Heldr. **D.** *Centaurothamnus maximus* (Forssk.)Wagenitz & Dittrich. **E.** *Zoegea mianensis* Bunge ex Boiss. Photos: **A, C-E,** A. Susanna; **B,** M. Bonifacino.

After these three preliminary steps, the way is clear to study in depth the radiations of the great genera of the tribe and in fact we have already finished the study of the first, that of the *Jurinea*. According to our results, the radiation of *Jurinea* in the Irano-Turanian region was mainly triggered by changes in climate (aridification and cooling) that followed the transition from Pliocene to Pleistocene.

None of these achievements, which have revolutionized our concept of the tribe and solved centuries-old taxonomic problems, would have been possible without the creation of the Cardueae Radiations Group. The more the merrier was a theme of the late Vicki Funk, and it was a guiding principle that she followed when creating the TICA. We have our own version in Spanish: *más seremos, más reiremos* (the more we will be, the more we will laugh), which demonstrates that this is old wisdom. From here I encourage our colleagues to follow suit; it works.

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Baccharis L. (Astereae): From Nova Scotia to Cape Horn

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Baccharis L. (Astereae Cass.) occurs naturally in the Americas (Figure 1), from Nova Scotia (*B. halimifolia* L.) to Cape Horn (*B. magellanica* Pers.) and from Northeastern Brazil Easternmost continental coast (*B. cinerea* DC.) to the USA Pacific Northwest coast (*B. pilularis* DC.), including the Caribbean, Galápagos, and Falkland/Malvinas islands. Within this area, 442 species are currently recognized and consist mainly of shrubs, though the genus also comprises varied habits, ranging from herbaceous plants to trees, including climbing shrubs (Figure 2). These species occupy a wide variety of environments, ranging from seashores to the soaring heights of the Andes at 5,000 m a.s.l., and from tropical rainforests to dry deserts and the cold Patagonian steppes and tundra (Figure 3, Figure 4, Figure 5).

The genus is particularly diverse in South America (Figure 1), with two main centers of both phylogenetic and species richness with high rates of endemism. The most important area, where the seven main phylogenetic lineages and almost half of the species are found, lies along the Eastern Brazilian highlands, from the table mountains of Chapada Diamantina in Bahia state, extending south to the Uruguayan Pampean hills. The second most speciose area, but with somewhat less phylogenetic representativeness, and also a high rate of endemism lies along the

Andes mountain range, especially between Bolivia and Peru. The spread to North America and the West Indies also resulted in important secondary centers of diversity and endemism north of the equator. In several open areas such as alpine vegetation, coastal scrubs, grasslands, Mediterranean vegetation, mountain slopes and savannas, species of *Baccharis* may be the dominant element of the vegetation defining the physiognomy of the natural landscape.

The generic name *Baccharis* has its origin in *bakkaris*, a designation applied by Dioscorides to the plant *Cyclamen hederifolium* Aiton (Primulaceae) with which an ointment for medicinal use was prepared (Quatrocchi, 1999). The resinous look of the plant may have reminded Linnaeus of the properties associated with the name present in Dioscorides' pharmacopeia, and although the plant referred to by the Greek botanist had nothing to do with these American plants, the reason was sufficient for the Swede to inscribe the name for posterity. In fact, many species of *Baccharis* are widely used as medicine to treat mainly liver diseases or digestive disorders. There are even different types of beverages that include compounds extracted from some *Baccharis* species. Conversely, some species are heavily toxic, especially for cattle (e.g. *B. coridifolia* DC. and

Baccharis

Heiden & Bonifacino | HEAD TOPICS

992.4



5 cm

From
**Dioscorides
to Linnaeus**

The name *Baccharis* was originally used by Dioscorides to refer to a plant in his pharmacopeia. It was later taken by Linnaeus to refer to a plant also supposed to possess medicinal properties.

Baccharis halimifolia L., the type of the genus.
Image courtesy and by permission of the Linnean Society of London.

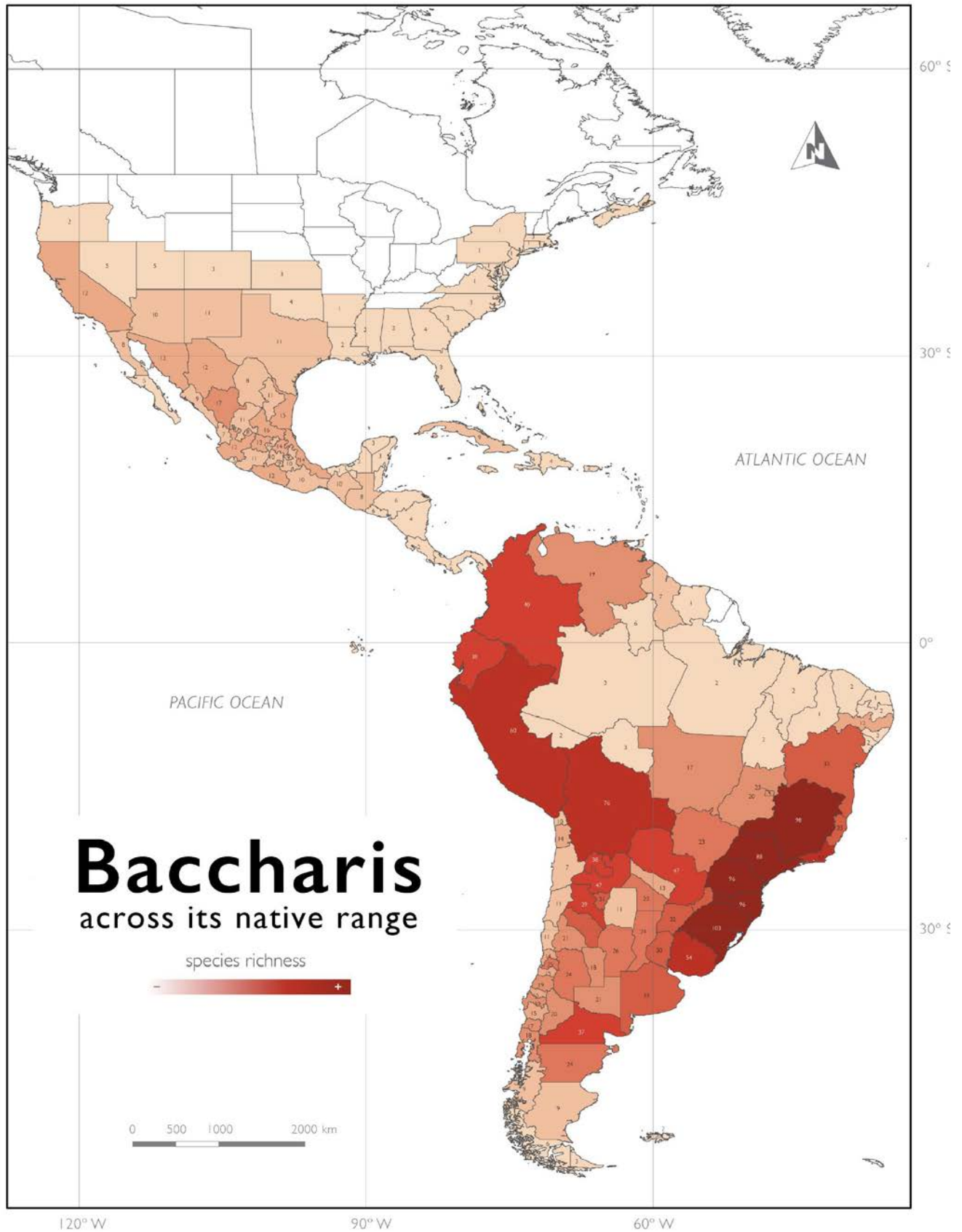


Figure 1. *Baccharis* L. distribution and species richness by territory across its native range. Darker colors represent higher species richness. Blank areas have no species recorded so far. Number of species are given within political subdivisions at TWG4.

Along the extensive coastal mountain range from Eastern Brazil...

Baccharis L. species usually constitute a characteristic and at times dominant element of the open and climax scrub vegetation. The rare *Baccharis magnifica* G.Heiden, Leoni & J.Nakaj. stands out on the summit of Pico da Bandeira (2890 m a.s.l.), the highest peak in the Eastern side of South America. Brazil also stands out accounting 185 species of *Baccharis*, 114 of them endemic, the highest number recorded for a single country.

Baccharis magnifica in Parque Nacional do Caparaó, border of Espírito Santo and Minas Gerais, Brazil.
Photo: G. Heiden



...all the way south
to Southeastern
Uruguay.

In this image *Baccharis aliena* (Spreng.) Joch. Müll. dominates the rocky outcrops landscape in Uruguay, where the genus, with 54 species (five endemic) is the country's most species-rich.

Baccharis aliena in Cerro Verdún, Lavalleja, Uruguay.
Photo: M. Bonifacino



Figure 2. Habit diversity in *Baccharis*. **A.** Shrubby *B. uncinella* DC. from the subtropical highland grasslands, Lages, Santa Catarina, Brazil. **B.** Herbaceous *B. nivalis* (Wedd.) Sch.Bip. ex Phil. from the Patagonian Andes at Los Glaciares NP, Santa Cruz, Argentina. **C.** Subshrubby *B. ciliata* Gardner from the rock outcrops of Organ Mountains, Teresópolis, Rio de Janeiro, Brazil. **D.** Tree of *B. longiattenuata* A.S.Oliveira from seasonally semideciduous forests of Arroio do Padre, Rio Grande do Sul, Brazil. **E.** Scandent shrubby *B. anomala* DC. from the coastal scrubs of São Lourenço do Sul, Rio Grande do Sul, Brazil. Photos: **A, C-E** G. Heiden; **B**, M. Bonifacino.

B. megapotamica Spreng.), likely due to the coevolution with endophytic fungi that synthesize macrocyclic trichothecenes (Jarvis et al., 1987, 1991). The genus is chemically as diverse as it is morphologically and ecologically, being widely explored for applications for industrial and pharmaceutical purposes, including drug discovery for cancer and noxious viral and bacterial diseases (Campos et al., 2016). *Baccharis* has also been explored in search of cultivars for ornamental purposes (for example *B. halimifolia* L., *B. pilularis* DC. and *B. sarothroides* A.Gray). Some species also cause negative economic impacts as weeds (*B. articulata* (Lam.) Pers., *B. coridifolia* DC., *B. dracunculifolia* DC., *B. halimifolia* L., *B. neglecta* Britton, *B. punctulata* DC.,

and *B. trimera* (Less.) DC.), phreatophytes (*B. salicifolia* (Ruiz & Pav.) Pers.) and pyrophytes (*B. pilularis* DC., *B. sarothroides* A.Gray) (Boldt, 1989; Thompson et al., 1995).

Being such an abundant genus of plants and with such a wide distribution, it is not surprising that many of the members of the pantheon of researchers of the Compositae have proposed generic segregates or coined diverse and frequently discordant proposals of infrageneric classifications. Although the concept of the genus has varied throughout history (see Heiden et al. 2019), mainly because several authors have focused mostly on the reproductive behavior of the whole plant or species, rather than on the



Figure 3. A. Salt streams margins and salt flats are the extreme habitat of *B. acaulis* (Wedd. ex R.E. Fr.) Cabrera, noticeable as the light green moss-like vegetation covering the margins of this seasonal water course at 3,750 m a.s.l., Ticatica, Potosí, Bolivia. **B.** *B. acaulis* moss-like herbaceous appearance, with rosulate and linear leaves above ground, hides a buried rhizomatous subshrub with underground leaves reduced to scales. Photos: **A.** G. Heiden; **B.** M. Bonifacino.



Figure 4. *Baccharis* habitats accross biomes. **A.** The greyish subshrubby *B. albilanosa* A.S.Oliveira & Deble in the pampas of Manoel Viana, RS, Brazil. **B.** The greyish decumbent subshrubby *B. gnaphalioides* Spreng. on coastal dunes at Tavares, RS, Brazil. **C.** Shrubby *B. arenaria* Baker in coastal wetlands at Lago Merín, Cerro Largo, Uruguay. **D.** Shrubs of *B. pingraea* DC. in Chacoan savanna at Barra do Quaraí, RS, Brazil. Photos: G. Heiden.



Figure 5. *Baccharis* habitats across biomes (cont.). **A.** Shrubby *B. nitida* (Ruiz & Pav.) Pers. on mountain slopes of the Yungas rainforests from Coroico, Bolivia. **B.** Shrubs of *B. boliviensis* (Wedd.) Cabrera in the semidesert Puna vegetation in Isla Incahuasi, Salar de Uyuni, Oruro, Bolivia. **C.** Subshrubs of *B. wrightii* A. Gray in the Chihuahuan Desert, Valencia, New Mexico, USA. **D.** The creeping subshrub *B. caespitosa* (Ruiz & Pav.) Pers. covering exposed rolled rocks at 4500 m a.s.l. along the Carretera de la Muerte, La Paz, Bolivia. Photos: G. Heiden.

individualized form and function of the reproductive structures, the genus circumscription is currently back to its original broader conception, though with a twist. *Baccharis* is now defined on the basis of the presence and predominance of functionally staminate monoclinal florets and diclinous pistillate florets, generally arranged in distinct mostly homogamous capitula usually located in distinct plants (Figure 7, Figure 8), e.g. functionally dioecious plants, with the exception of *B. monoica* G.L.Nesom, which has functionally staminate and pistillate capitula in the same specimen. Capitula bearing fully functional monoclinal florets allegedly could occur in one species (e.g. *B. pohlii* (Baker) Deble & A.S.Oliveira); however, their peculiar biology in the context of the genus characteristics should be further investigated with field studies. The scattered and accidental occurrence of a few monoclinal central or marginal florets is not rare in functionally pistillate capitula of several species from unrelated sections and subgenera. Similarly, sterile pistillate marginal florets can sometimes occur in functionally staminate capitula across several unrelated lineages. Further adding to this floral diversity, some clades consistently have heterogamous capitula (e.g., the sister species *B. breviseta* DC. and *B. vulneraria* Baker; the three species belonging to *Baccharis* sect. *Heterothalamus* (Less.) Giuliano. Species or individuals that do not conform to this rigid combination of functionally staminate/pistillate florets and arrangement of capitula across plants can be considered as the queer result of the evolutionary exploration of a genus willing to be bold, as depicted in Figure 9. As in nature, success and resilience in *Baccharis* is determined by diversity.

Most *Baccharis* species present a unique arrangement of fused trichomes sharing the same single basal cell. These fused trichomes, referred to as “tufted indument” (Figure 6) are composed of uniseriate and biseriate glandular types and were first described by Volken (1890). The trichomes making up the tufted indumentum are located in micro depressions along the surface of the leaves, and exudate a resin layer that confer the distinctively oily and bright appearance of many species. These tufted vestiture has been considered a probable synapomorphy of the whole genus (Müller 2006). However, it is absent in *Baccharis* subgen. *Tarchonanthoides* Heering, the first diverging lineage (Heiden et al.



Figure 6. Indument in *Baccharis*. **A.** Detail of young leaf of *Baccharis dracunculifolia*, notice that there is a conspicuous indument of uniseriate trichomes (with branched terminal cell) easily visible at naked eye shadowing an almost inconspicuous microindument of uniseriate and biseriate glandular trichomes, some of them free, while the majority are packed in clusters with a single adjoining basal cell and placed in minute cavities conforming the so-called tufted indument characteristic of the vast majority of the genus. **B.** Close up of the “punctate-glandular” tufted microindument. Photos: M. Bonifacino.

2019), demonstrating that this novel trait appeared later in the genus, being present as a synapomorphy of the subsequent diverging lineages, although with complete reversions in *Baccharis* subgen. *Coridifoliae* (DC.) G.Heiden and in some sections or species of *B.* subgen. *Heterothalamus* (Less.) G.Heiden, *B.* subgen. *Molina* (Pers.) Heering and *B.* subgen. *Baccharis*.

CAPITULUM ORGANIZATION

distribution of monoicinus and diclinous florets across heads & plants

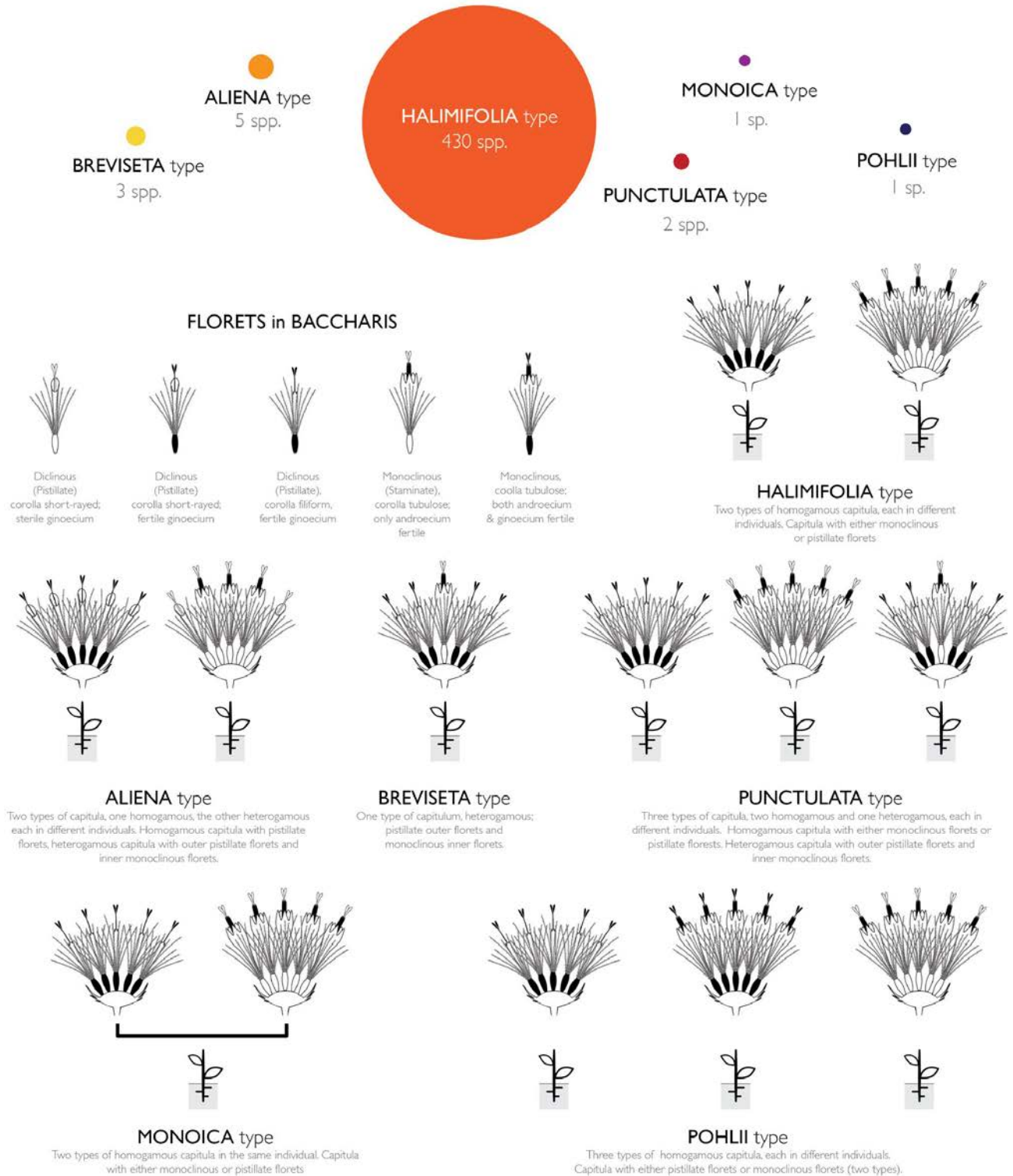
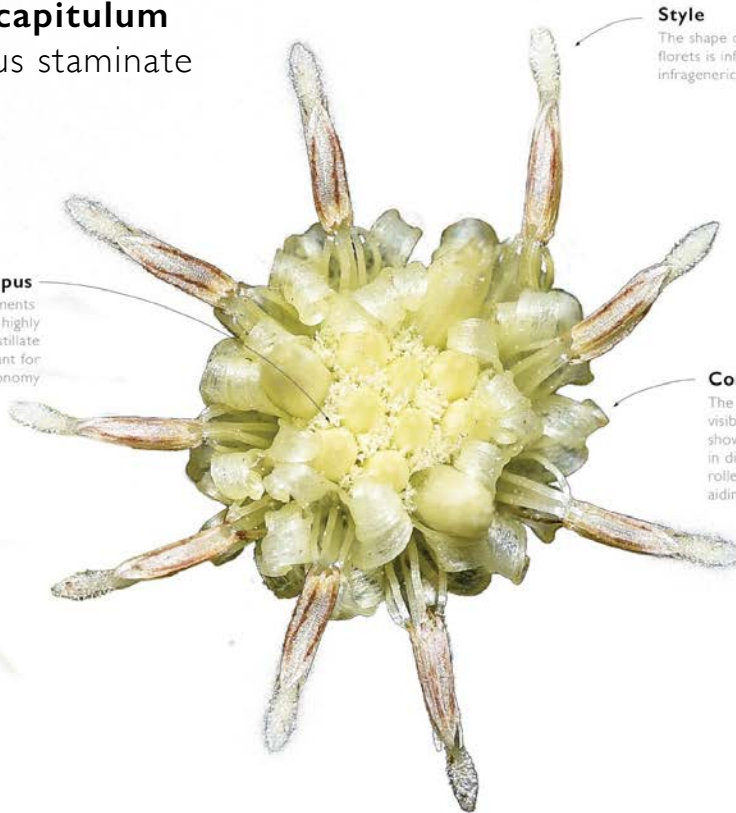


Figure 7. Capitulum organization infographic, showing the distribution of florets in capitula and across plants in *Baccharis* (circle size is proportional to number of species). Notice the dominance of the characteristic Halimifolia type, present in over 97 % of the species.

Homogamous capitulum with monoclinal staminate florets

Pappus
The shape of the pappus elements on staminate florets contrasts highly with the same structure in the pistillate florets and is taxonomically relevant for *Baccharis* infrageneric taxonomy



Style
The shape of the style on staminate florets is informative for *Baccharis* infrageneric taxonomy

Corolla
The corolla is one of the most visible structures in the staminate head, showing diversity both in shape as well as in disposition of the lobes, which could be rolled up like in this case or totally extended, aiding identification

Homogamous capitulum with declinous pistillate florets

Corolla
Contrasting highly with what happens in the staminate florets, the corolla in pistillate florets usually remains hidden due to the exposure of the styles



Styles
The styles are generally the most showy part of pistillate capitula before fertilization. In some groups style length is surpassed by the pappus during fruit development.

Figure 8. Superior view of two homogamous capitula conforming the Halimifolia type, the commonest arrangement found in 97% of the species of *Baccharis*. Photos: M. Bonifacino.



Figure 9. Examples of main types of capitula in *Baccharis*. **A.** Homogamous capitulum with pistillate florets with filiform corollas (*B. megapotamica* Spreng.). **B.** Homogamous capitulum with staminate florets with tubulose corollas (*B. pingraea* DC.). **C.** Heterogamous capitulum with outer pistillate florets with filiform corollas and inner monoclinal florets with tubulose corollas (*B. vulneraria* Baker). **D.** Homogamous capitulum with pistillate florets with short-rayed corollas (*B. aliena* (Spreng.) Joch.Müll.). **E.** Heterogamous capitulum with outer pistillate florets with short-rayed corollas and inner monoclinal florets with tubulose corollas (*B. aliena*). Photos: M. Bonifacino.

It is something remarkable and curious to point out that, unlike what occurs in the style of monoclous florets of most *Astereae*, in *Baccharis*, the two marginal stigmatic bands are absent, communicating the exclusive staminate functionality in a formidable way and reassuring the irreplaceable function of the pistilodium for the secondary pollen exposure characteristic of the family. Another remarkably distinctive trait that we can also link to the functionality of the florets is the shape of the pappus elements. In monoclous florets, the pappus elements have a frizzy appearance and usually have longer ornamentations and an apex broader than

those usually observed in the pistillate florets, where the elements are straight, without the frizz and commonly not or only slightly broadened towards the apex (Figure 11).

It is usual to feel somewhat intimidated or lost when faced with having to identify a specimen belonging in a genus with more than four hundred species that has not been approached taxonomically as a whole since Candolle (1836). The problem thickens as recent floras with treatments for *Baccharis* are lacking for most of the areas where it occurs. The task of identifying an unknown *Baccharis* specimen



Figure 10. An individual with homogamous capitula containing pistillate florets of *Baccharis platypoda* DC. showing the remarkable capitulescence composed by secondary capitula. This arrangement is an unusual trait within the genus found in a few not so closely related species of *Baccharis* subgen. *Baccharis*. Photo: G. Heiden.

is also challenging, especially to those unfamiliar with the group, because some easily accessible macrocharacters such as habit, apterous or winged stems, leaf shape, capitula arrangement (Figure 10), are frequently misleading due to convergence or homoplasy. To overcome these barriers, one needs to know where to look at and what to look for as some reproductive traits (Figure 11) and microcharacters (Table 1), when combined, are useful to restrict the search to the level of subgenera and sections. Indeed, just by observing the indumentum, the shape of the pappus elements and style apex in monoclinal florets, the structure and development of pappus and type of corolla apex in pistillate florets and the number of ribs in the cypselae (Figure 14) gives one ammunition to greatly reduce a group of hundreds of species to just a few or, at most, a few dozen species (Figure 13). Conversely, the habit, the presence or absence of winged stems, the shape of leaves and the types of capitulescences (Figure 10) present a formidable variation that assists in the identification of species within infrageneric groups, although it is often of little help for defining subgenera or sections.

Notwithstanding the current sampling effort, including 35 out of 47 sections and more than half of the species, a thorough phylogenetic sampling encompassing representatives of all sections is still lacking. This is particularly important for the sections of unknown relationships within *Baccharis* subgen. *Baccharis* (*B. sect. Discolores* DC., *B. sect. Divaricatae* Giuliano, *B. sect. Frenguellianae* Giuliano, and *B. sect. Pedicellatae* Heering) and *Baccharis* subgen. *Molina* (*B. sect. Albidae* Giuliano, *B. sect. Aristidentes* G.L.Nesom, *B. sect. Gladiatae* Cuatrec., *B. sect. Pinnatae* Cuatrec., *B. sect. Punctatae* Giuliano & G.L.Nesom, *B. sect. Rodriguezianae* Giuliano, *B. sect. Tenellae* Giuliano, and *B. sect. Tubulatae* Cuatrec.), as well as the unplaced species at sectional level within these same subgenera (16 in *Baccharis* subgen. *Baccharis* and 17 in *B. subgen. Molina*). In addition to the gaps in phylogenetic representativeness, there still remain important geographical sampling voids, particularly for species endemic to Mexico, Peru and Venezuela.

The classification published by Heiden et al. (2019) paved the way to a better understanding of this truly remarkable group. However, some of the clades retrieved still lack morphological backing (Figure 13), and the answer to this may be hidden in both

microcharacters and those derived from chemical markers. The genus is currently divided into seven subgenera and 47 sections (Figure 12). We provide below a summary of this subgeneric classification, with brief descriptions of each subgenus and information on its conformation in terms of the number of sections and constituent species. For sections, a table with key traits is provided (more detailed information on the sections and species assigned to each subgenus can be found in Heiden et al. 2019).

TAXONOMIC SYNOPSIS

Baccharis Sp. Pl.: 860. 1753. Type: *Baccharis halimifolia* L., typ. cons.

Seven subgenera, 47 sections and 442 species (and counting!).

Baccharis subgen. ***Tarchonanthoides*** Heering, Jahrb. Hamburg. Wiss. Anst. 21(3): 26, 1904. (as “*Tarchonantoides*”).

Type: *Baccharis tarchonanthoides* DC.

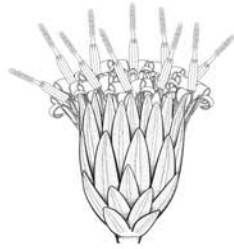
Trees, shrubs, or subshrubs. Indument not tufted, mostly of filiform trichomes. Stems apterous. Leaves developed. Capitula homogamous, structure and arrangement of *Halimifolia* type. Receptacle of pistillate capitula epaleate. Staminate florets with pappus elements linear and scabrid towards the apex, pistillodium apex linear-oblong. Pistillate florets with corollas tubular-filiform with denticulate apex. Cypselae 2 to 8(10)-ribbed; pappus persistent, multiseriate, acrescent or not.

Southeastern South America open vegetations; two sections and 13 species.

Baccharis subgen. ***Oblongifoliae*** (DC.) G.Heiden, Phytotaxa 289(3): 289, 2016. (≡ *Baccharis* sect. *Oblongifoliae* DC., Prodr. 5: 416. 1836. Type (designated by Cuatrecasas in Revista Acad. Colomb. Ci. Exact. 13: 66. 1967): *Molina oblongifolia* Ruiz & Pav. (≡ *Baccharis oblongifolia* (Ruiz & Pav.) Pers.).

Trees, shrubs, scandent shrubs, or subshrubs. Indument tufted, uniseriate, pedestal and/or biseriate glandular trichomes. Stems apterous.

CAPITULA



Homogamous
Staminate florets
with tubulose corollas



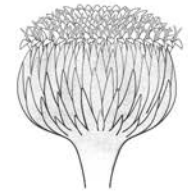
Homogamous
Pistillate florets
with filiform corollas



Heterogamous
Outer pistillate florets
with pistillate corollas and
inner monoclinal florets
with tubulose corollas

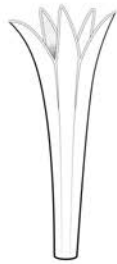


Heterogamous
Outer pistillate florets
with short-rayed corollas and
inner monoclinal florets
with tubulose corollas

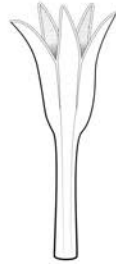


Homogamous
Pistillate florets
with short-rayed corollas

COROLLAS OF STAMINATE FLORETS



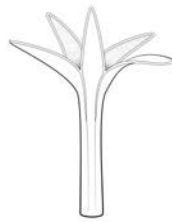
Tubulose
gradually
broadened



Tubulose
abruptly
broadened

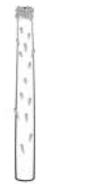


Hipocrateriform,
tube long

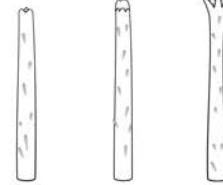


Hipocrateriform,
tube short

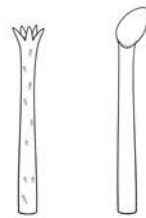
COROLLAS OF PISTILLATE FLORETS



Filiform with truncate
apex with subapical
wreath of trichomes

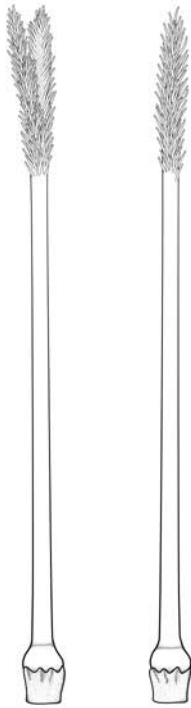


Filiform
with denticulate apex

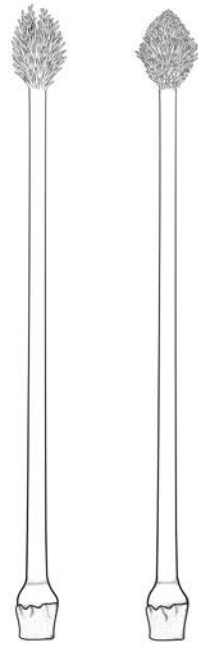


Short rayed

STYLES



Apex linear-oblong



Apex ovate-capitate



Style of
pistillate florets

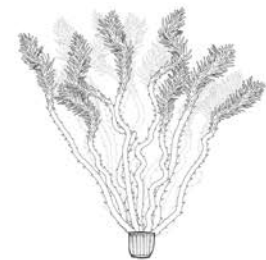
Pistilodium of monoclinal florets
Style branches arms range from free to totally fused and
bear sweeping trichomes of equal or unequal lengths.

PAPPUS



Tapering & scabrid
pappus elements

This type occurs typically in pistillate florets,
but also on staminate florets depending on the species.



Clavate and barbelate pappus elements

This type is commonly found in pappus of staminate
florets, but it can also occur in pistillate florets depend-
ing on the species. The freezy appearance however,
is exclusive of staminate florets

CYPSELAE



<5 ribs



5 to 8 ribs



>8 ribs

Cypselae can be glabrous as depicted here but they
also frequently show varied indument types

Figure 11. Some morphological reproductive characters important for the infrageneric taxonomy and useful in the identification of *Baccharis*.

The wings of Baccharis

Some groups of *Baccharis* L. show an unusual stem and leaf development, as seen here in *Baccharis jocheniana* G.Heiden & L.Macias in Southern Uruguay. In these winged plants, the lamina has a decurrent base that extends considerably along the stem down to the next two immediate nodes, giving the stem its characteristic alate appearance.

Baccharis jocheniana in Lavalleja (Uruguay)
Photo: M. Bonifacino

CLASSIFICATION OF BACCHARIS

INFRAGENERIC DIVERSITY PLOTTED ON AN UNROOTED PHYLOGENY

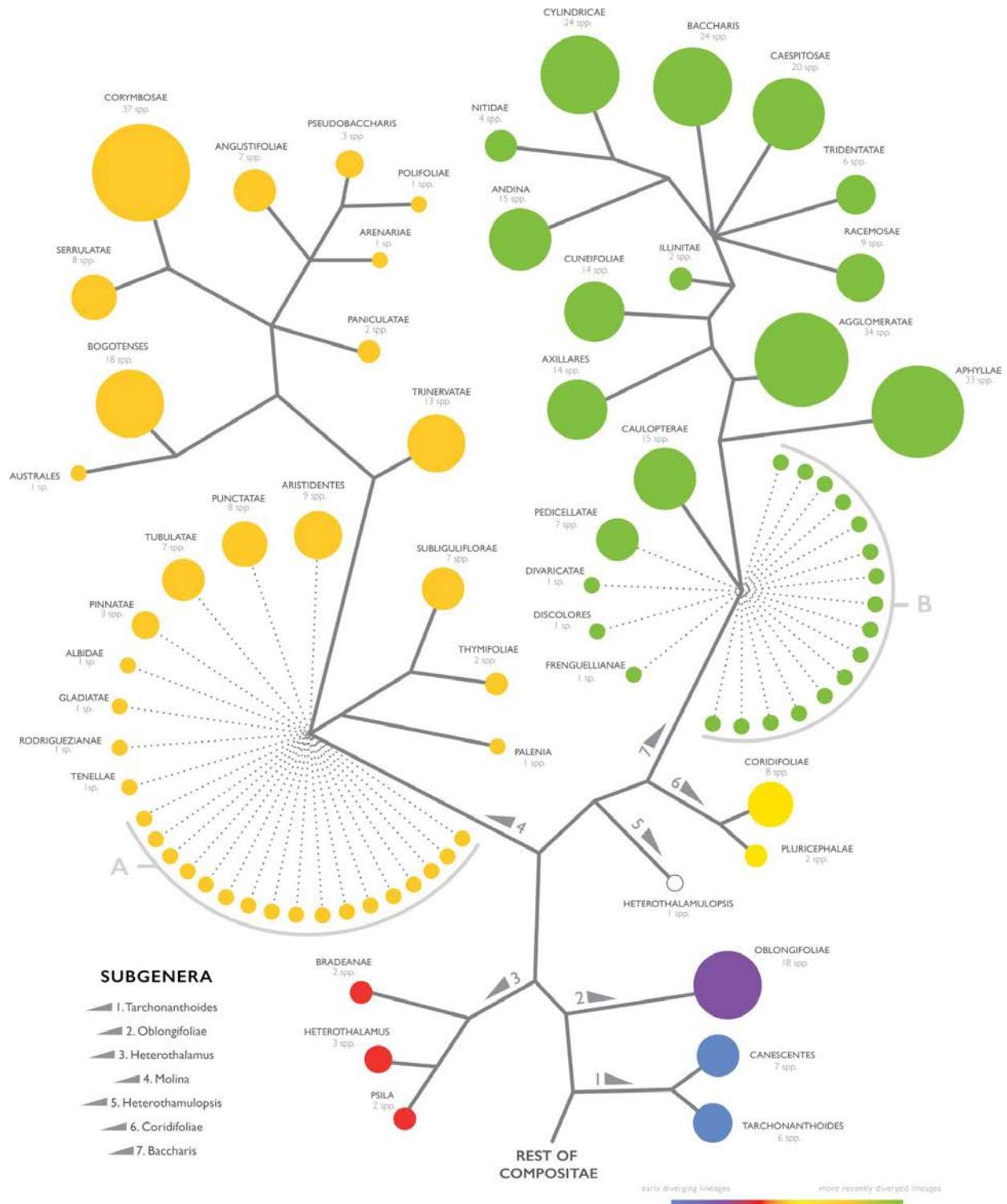


Figure 12. Unrooted phylogeny of *Baccharis* (adapted from Heiden et al. 2019). Circle size is indicative of species number. Dotted lines indicate sections or species with uncertain or undetermined relationships (placed within subgenera based on morphology but with pending subgeneric relationships corroborated by molecular data). **A.** Species belonging to *Baccharis* subgen. *Molina* but not formally assigned to sections. **B.** Species belonging to *Baccharis* subgen. *Baccharis* but not formally assigned to sections.

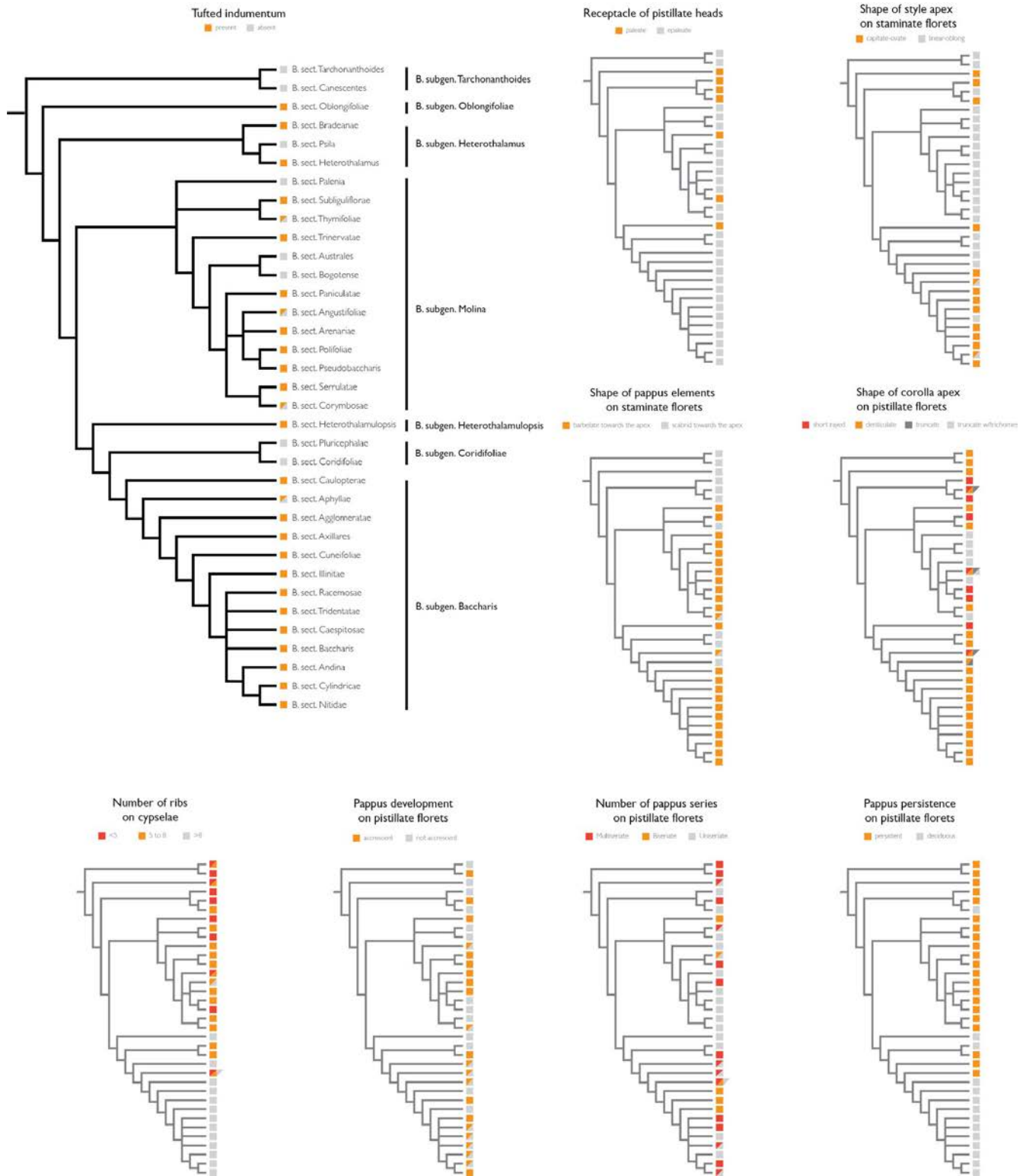


Figure 13. Selected morphological characters useful for identification of *Baccharis* infrgeneric groups. The characters are plotted in a summarized phylogeny based on Heiden et al. (2019).

Table I. Data matrix of morphological characters useful in the identification of *Baccharis* infrageneric groups. Names in **bold** face indicate taxa included in the phylogeny by Heiden et al. (2019). For characters used and their states see Table 2.

Subgenera	Sections	Characters											
		1	2	3	4	5	6	7	8	9	10	11	12
B. subgen. Tarchonanthoides	B. sect. Tarchonanthoides	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Canescentes	■	■	■	■	■	■	■	■	■	■	■	■
B. subgen. Oblongifoliae	B. sect. Oblongifoliae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Bradeanae	■	■	■	■	■	■	■	■	■	■	■	■
B. subgen. Heterothalamus	B. sect. Heterothalamus	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Psila	■	■	■	■	■	■	■	■	■	■	■	■
B. subgen. Molina	B. sect. Palenia	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Subliguliflorae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Thymifoliae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Trinervatae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Australes	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Bogotenses	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Paniculatae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Arenariae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Polifoliae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Pseudobaccharis	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Angustifoliae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Serrulatae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Corymbosae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Albidae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Aristidentes	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Gladiatae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Pinnatae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Punctatae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Rodriguezianae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Tenellae	■	■	■	■	■	■	■	■	■	■	■	■
B. sect. Tubulatae	■	■	■	■	■	■	■	■	■	■	■	■	
B. subgen. Heterothalamulopsis	B. sect. Heterothalamulopsis	■	■	■	■	■	■	■	■	■	■	■	
B. subgen. Coridifoliae	B. sect. Pluricephalae	■	■	■	■	■	■	■	■	■	■	■	
	B. sect. Coridifoliae	■	■	■	■	■	■	■	■	■	■	■	
B. subgen. Baccharis	B. sect. Caulopterae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Aphyllae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Agglomeratae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Axillares	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Cuneifoliae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Illinitae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Racemosae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Tridentatae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Caespitosae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Baccharis	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Andina	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Cylindricae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Nitidae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Discolores	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Divaricatae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Frenguellianae	■	■	■	■	■	■	■	■	■	■	■	■
	B. sect. Pedicellatae	■	■	■	■	■	■	■	■	■	■	■	■

Table2. Characters and character states useful in identification of *Baccharis*.

Characters	Character's state
Habit	1 Shrub, 2 Subshrub, 3 Tree, 4 Scandent shrub, 5 Herb, 6 Rhizomatous shrub
Tufted indumentum	2 Present, 3 Absent
Capitulum structure	3 Halimifolia type, 4 Aliena type, 5 Monoica type, 6 Punctulata type, 7 Breviseta type, 8 Pohlil type
Staminate capitula	4 Discoid, 5 Heterogamous, marginal corollas short-rayed, 6 Heterogamous, marginal corollas long-rayed
Shape of style apex on staminate florets	5 Capitulate-ovate, 6 Linear-oblong
Shape of pappus elements on staminate florets	6 Barbelate towards the apex, 7 Scabrid towards the apex
Shape of corolla apex on pistillate florets	7 Short rayed, 8 Denticulate, 9 Truncate, 10 Truncate apex with subapical wreath of trichomes
Receptacle of pistillate capitula	8 Paleate, 9 Epaleate
Number of pappus series on pistillate florets	9 Multiseriate, 10 Biseriate, 11 Uniseriate
Pappus persistence on pistillate florets	10 Persistent, 11 Deciduous
Pappus development on pistillate florets	11 Accrescent, 12 Not accrescent
Number of ribs on cypselae	12 <5, 13 5 to 8, 14 >8

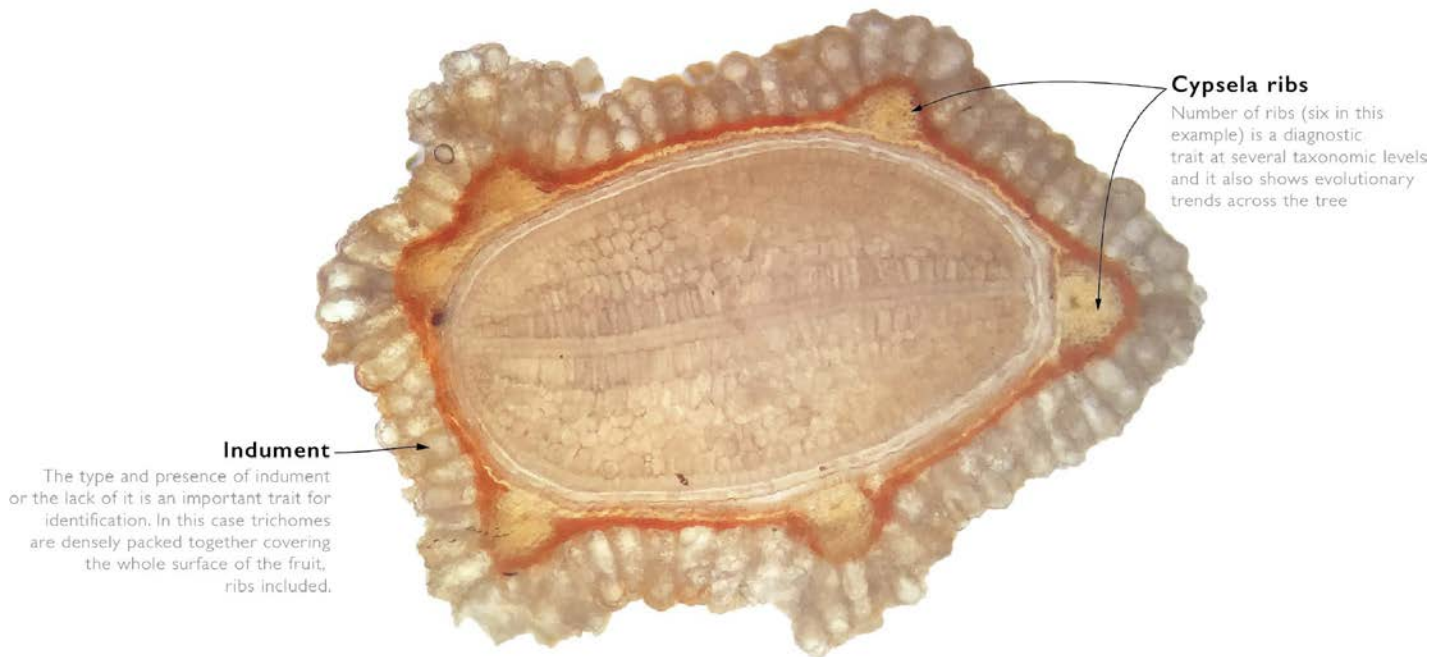


Figure 14. Cross section of the cypselum of *Baccharis patens* Baker showing the presence of six ribs. Number of ribs is a character readily determined by means of producing a bare hand simple section like this. Notice copious indument covering the whole surface. Photo: M. Bonifacino.

Leaves developed. Capitula homogamous, structure and arrangement of Halimifolia type. Receptacle of pistillate capitula paleate. Staminate florets with pappus elements clavate and scabrid towards the apex, pistillodium apex capitate. Pistillate florets with corollas filiform with denticulate apex. Cypselae 3 to 7-ribbed; pappus persistent, multiseriate, not accrescent.

High slopes and mountain summits across tropical and subtropical South America; one section and 18 species.

Baccharis subgen. **Heterothalamus** (Less.) G.Heiden, Phytotaxa 289(3): 288, 2016. (≡ *Heterothalamus* Less. in *Linnaea* 5: 145. 1830. Type: *Marshallia aliena* Spreng. (≡ *Baccharis aliena* (Spreng.) Joch.Müll.).

Trees, shrubs, and rhizomatous subshrubs. Indument tufted or not, pedastal trichomes or glabrous. Stems apterous. Leaves developed on aerial branches or sometimes reduced to scales in underground rhizomes. Capitula homogamous or heterogamous, structure and arrangement of Halimifolia or *Aliena* type. Receptacle of pistillate capitula paleate. Staminate florets with pappus elements linear and scabrid towards the apex, pistillodium apex capitate. Pistillate florets with corollas tubular and with short-rayed apex, or filiform with denticulate or truncate apex. Cypselae 3 to 5(6)-ribbed; pappus deciduous or persistent, uniseriate or multiseriate, accrescent or not.

Mountains, rocky outcrops, sandy or salty soils along the Andes and the Eastern South American mountainous and hilly ranges; three sections and seven species.

Baccharis subgen. **Molina** (Pers.) Heering, *Schriften Naturwiss. Vereins Schleswig-Holstein* 13: 40, 1904. (≡ *Molina* Ruiz & Pav., *Prodr. Fl. Peruv.*: 111, t. 24. 1794, non *Molina* Cav. 1790 (Malpighiaceae), nec *Molina* Gay 1851, 1852 (Euphorbiaceae) ≡ *Baccharis* [unranked "group"] *Molina* Pers., *Syn. Pl.* 2: 424. 1807. Type (designated by Cuatrecasas in *Revista Acad. Colomb. Ci. Exact.* 13: 87. 1967): *Molina latifolia* Ruiz & Pav. (≡ *Baccharis latifolia* (Ruiz & Pav.) Pers.).

Trees, shrubs, scandent shrubs, subshrubs, rhizomatous subshrubs or herbs. Indument tufted

or not, flagellate, clavate, filiform, pedastal or curved uniseriate and/or biseriate glandular trichomes. Stems apterous. Leaves developed or reduced to scales. Capitula homogamous or heterogamous, structure and arrangement mostly of Halimifolia type, rarely *Breviseta*, *Monoica*, *Pohlilii* and *Punctulata* types. Receptacle of pistillate capitula generally epaleate, sometimes paleate. Staminate florets with pappus elements mostly linear and barbellate towards the apex, rarely scabrid towards the apex, pistillodium apex linear-oblong. Pistillate florets with filiform corollas and short-rayed, denticulate or truncate apex, the later with or without a subapical wreath of trichomes. Cypselae 5 to 8-ribbed; pappus mostly persistent, rarely deciduous, uniseriate, biseriate or multiseriate, generally accrescent, sometimes not.

Widespread in a plethora of habitats from deserts to rainforests, from seashores to high summits around 5,000 m asl, from the southwestern USA to southern South America, including oceanic islands; 21 sections and 150 species.

Baccharis subgen. **Heterothalamulopsis** (Deble, A.S.Oliveira & Marchiori) G.Heiden, Phytotaxa 289(3): 287, 2016. (≡ *Heterothalamulopsis* Deble, A.S.Oliveira & Marchiori in *Ci. Florest.* 14(1): 1. 2004. Type: *Heterothalamulopsis wagenitzii* (F.H.Hellw.) Deble, A.S.Oliveira & Marchiori (≡ *Baccharis wagenitzii* (F.H.Hellw.) Joch.Müll.).

Shrubs or subshrubs. Indument tufted. Stems apterous. Leaves developed. Capitula homogamous, structure and arrangement of Halimifolia type. Receptacle of pistillate capitula paleate. Staminate florets with pappus elements clavate and barbellate towards the apex, pistillodium apex capitate. Pistillate florets with corollas tubular and short-rayed apex. Cypselae 10-ribbed; pappus deciduous, uniseriate, not accrescent.

Endemic to the cloud forests on the edges of basaltic cliffs and canyons of southern Brazil; one section and one species.

Baccharis subgen. **Coridifoliae** (Giuliano) G.Heiden, Phytotaxa 289(3): 286 (2016). ≡ *Baccharis* sect. *Coridifoliae* Giuliano in *Ann. Missouri Bot. Gard.* 98(3): 339. 2011. Type: *Baccharis coridifolia* DC.

Shrubs or subshrubs. Indument not tufted, mostly filiform trichomes, sometimes trichomes paired



Vicki Funk's Baccharis

Baccharis funkiae Bonif., G.Heiden, Valtierra & Marchesi, a recently described species from the Uruguayan-Brazilian border, belongs in *B.* sect. *Cylindricae*, one of the five most species-rich sections in the genus. Notice the the tufted indument, the distinctive attenuated leaf base, cylindric capitula, and capitate style apex. The species honors the late Vicki Funk, a champion of Compositae research, who always fostered international collaboration and was the driving force behind the development of TICA. Her spirit lives on in many ventures, dispersed across borders like cypselae in the wind. This joint paper exemplifies that spirit, proving that political borders do not matter when Compositae matters.

Baccharis funkiae in Quebrada de los Cuervos, Treinta y Tres, Uruguay.
Photo: M. Bonifacino

or uniseriate, pedicel and/or biseriolate glandular trichomes. Stems apterous. Leaves developed. Capitula homogamous, structure and arrangement of *Baccharis* type. Receptacle of pistillate capitula epaleate. Staminate florets with pappus elements linear and scabrid towards the apex, pistillodium apex linear-oblong. Pistillate florets with corollas tubular-filiform with denticulate apex. Cypselae 5 to 8-ribbed; pappus deciduous or persistent, uniseriate or multiseriate, acrescent or not.

Grasslands and savannas from Bolivia and central Brazil, south to central Argentina across Paraguay and Uruguay; two sections and 10 species.

Baccharis subgen. ***Baccharis***.

Trees, shrubs, scandent shrubs, subshrubs or rhizomatous subshrubs. Indument mostly tufted, rarely not tufted, always with biseriolate glandular trichomes, uniseriate flagellate, clavate, filiform or bifurcate trichomes. Stems apterous, striated or alate due leaf basis decurrence. Leaves developed or reduced to scales. Capitula homogamous, rarely heterogamous, structure and arrangement mostly of *Halimifolia* type, rarely *Breviseta* or *Punctulata* types. Receptacle of pistillate capitula epaleate. Staminate florets with pappus elements mostly clavate and barbellate towards the apex, sometimes scabrid towards the apex, pistillodium apex, mostly capitate, sometimes linear-oblong. Pistillate florets with corollas filiform with denticulate apex, rarely short-rayed or truncate. Cypselae (3 to 7)8 to 12(20)-ribbed; pappus mostly deciduous, sometimes persistent, uniseriate, biseriolate or multiseriate, acrescent or not.

Widespread in a plethora of habitats from deserts to rainforests, from seashores to high summits around 5,000 m a.s.l. from the Northwestern USA and Southeastern Canada to Southern South America, including oceanic islands; 17 sections and 241 species.

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An overview of Neurolaeneae

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Neurolaeneae Rydb. (Figure 1) is a tribe in Compositae, originally proposed by Rydberg (1927) in his treatment for the North American Flora comprising two genera: *Neurolaena* R.Br. (Fig. 1E) and *Schistocarpha* Less. (currently Millerieae). Stuessy (1977) placed the group as a subtribe of Heliantheae Cass., but it was reestablished later in 2002 (Panero and Funk 2002). Although Rydberg (1927) originally considered the tribe to be closely related to Senecioneae Cass., molecular data later suggested it is sister to a clade that includes the tribes Bahieae B.G.Baldwin, Chaenactideae B.G. Baldwin, and Tageteae Cass. in the Heliantheae Alliance (Panero and Funk 2002). Panero (2007) established the current circumscription that includes five genera: *Calea* L. (Figure 1C), *Enydra* Lour. (Figure 1A), *Greenmaniella* W.M.Sharp (Figure 1D), *Heptanthus* Griseb. (Fig. 1B), and *Neurolaena*. Using a recent, family-wide phylogenomic dataset, Mandel et al. (2019) confirmed the placement of Neurolaeneae in the so-called “Heliantheae Alliance” and indicate it is sister to a clade that includes Heliantheae and Coreopsideae Lindl..

The tribe is found on most continents, except Antarctica and Europe, and it is present in 72 countries and nine overseas territories and departments (Figure 2). Three genera in Neurolaeneae are widespread: *Calea*, *Enydra* and *Neurolaena* and among these *Enydra* is the only genus naturally found outside the Americas, occurring in Africa (23

countries), Asia (13 countries) and Oceania (one country). *Neurolaena* is restricted to the Americas where it is known from 30 countries and eight territories in the Caribbean and one territory in South America. *Calea* is the third most widespread genus, occurring from Mexico to Argentina (but the genus is not known from Chile), including Jamaica and Trinidad and Tobago from the Caribbean, and *C. urticifolia* DC., introduced in Africa (Lawalrée 1982). *Heptanthus* and *Greenmaniella* are endemic to Cuba and Mexico, respectively.

Neurolaeneae is comprised of 179 species, and most species in the tribe belong to the genus *Calea* (154 species). Each of the other four genera is represented by far less species diversity, with *Neurolaena*, *Heptanthus*, *Enydra*, and *Greenmaniella* containing twelve, seven, five, and one species, respectively. Representatives of Neurolaeneae (Panero 2007) are recognized by a herbaceous to shrubby habit (rarely treelets); leaves commonly linear, ovate or trullate; capitula discoid or radiate arranged on paniculiform or corymbiform cymes (sometimes solitary); receptacle usually paleate (*Heptanthus* is exclusively epaleate, as are some species of *Calea* and *Neurolaena*); ray florets, when present, are pistillate, disc florets are monoclinal or functionally staminate; cypselae are blackish and the pappus is composed of bristles, scales, minute awns, or more rarely absent (in *Enydra*) (Figure 3).



Figure 1. Generic diversity of Neurolaeneae (Compositae). **A.** *Enydra* (*Enydra fluctuans* Lour.). **B.** *Heptanthus* (*Heptanthus shaferi* Britton). **C.** *Calea* (*Calea uniflora* Less.). **D.** *Greenmaniella* (*Greenmaniella resinosa* W.M. Sharp). **E.** *Neurolaena* (*Neurolaena lobata* R. Br.). Photos: **A,** L. Liao; **B,** J. L. Gomez; **C,** M. Bonifacino; **D,** C. G. Casanova; **E,** J. L. Gomez.

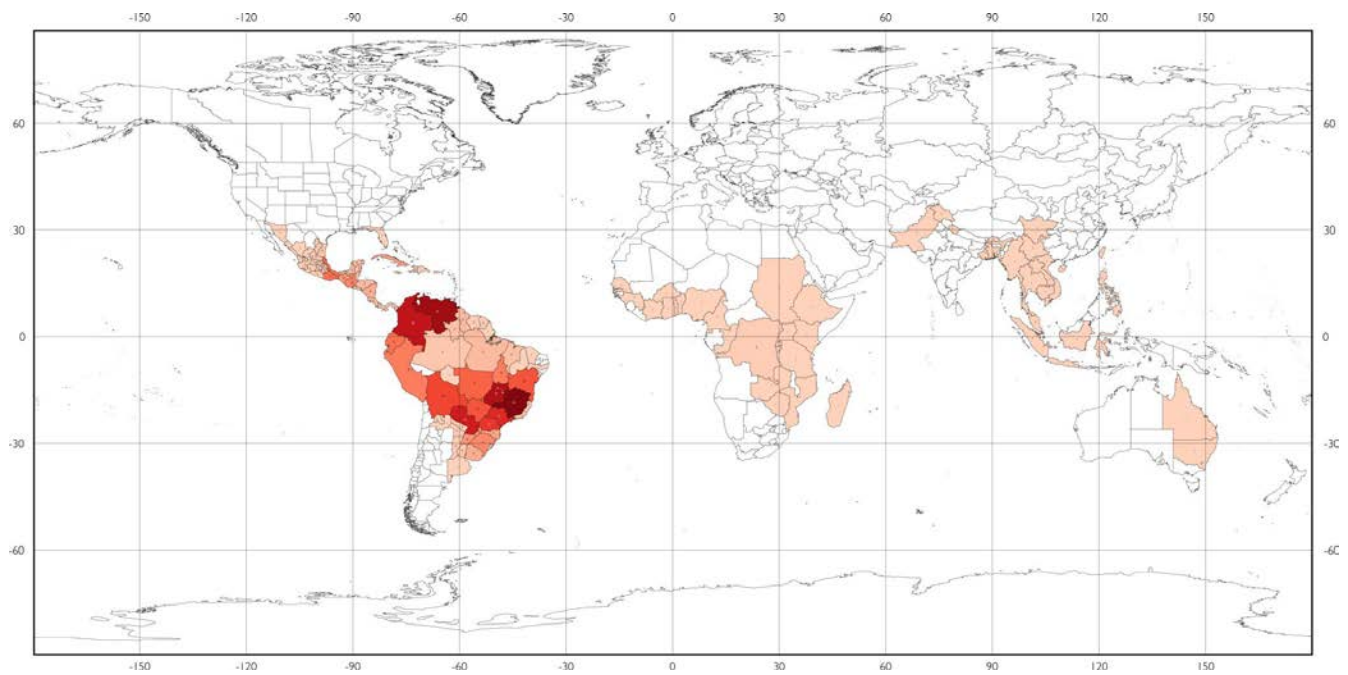
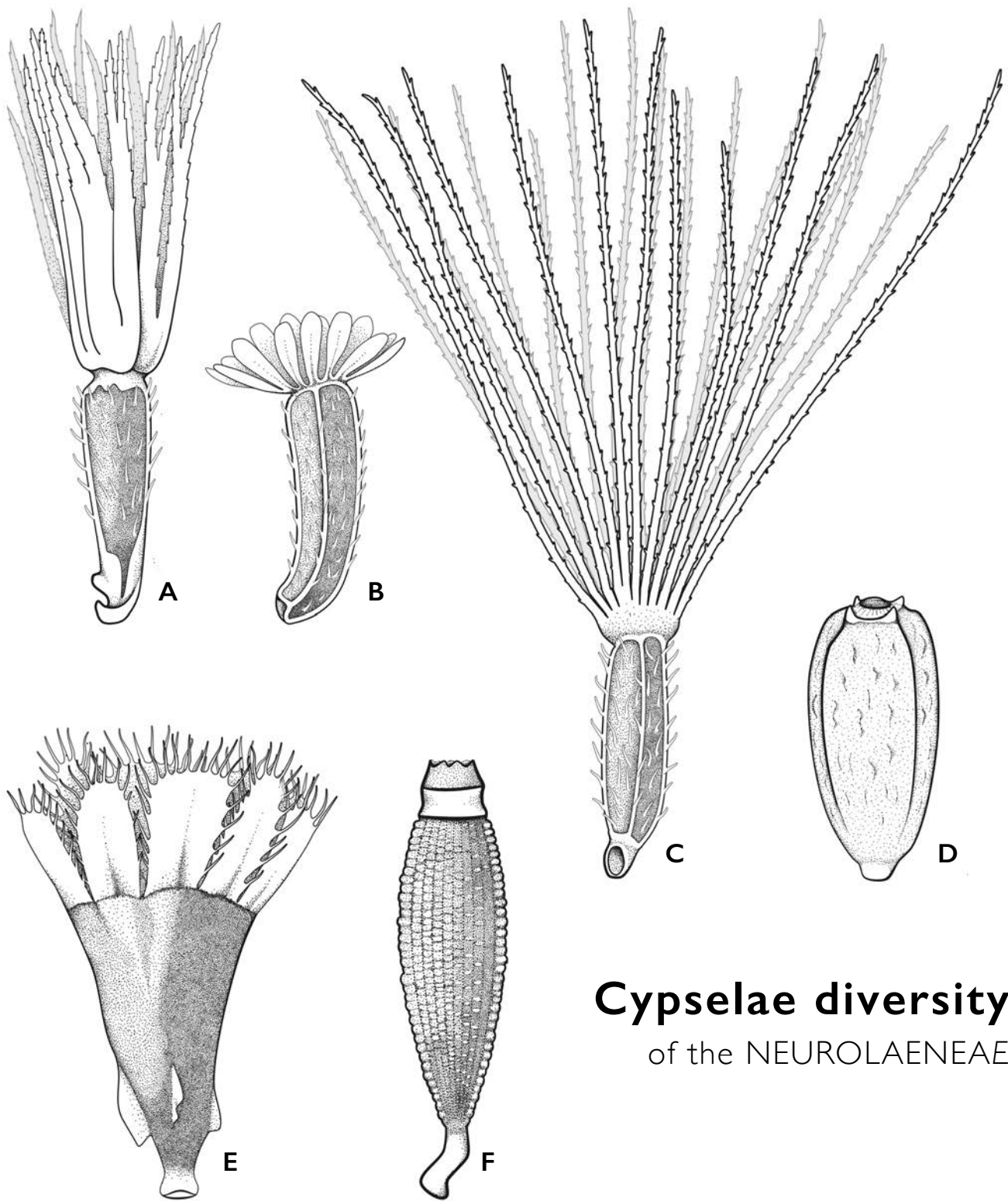


Figure 2. Global distribution and species diversity of the Neurolaeneae. The darker the color the greater the diversity. Notice the two hotspots (SE Brazil and Colombia-Venezuela). Three species of *Enydra* occurs naturally outside the Americas and *Calea urticifolia* was introduced in the Democratic Republic of Congo (Lawalrée 1982).

Enydra and *Heptanthus* are the only genera that are exclusively herbaceous. *Enydra* inhabits aquatic or wet areas, has opposite leaves, solitary sessile capitula, and is mainly characterized by four foliaceous phyllaries which form a cupulate involucre (Snow 1980; Panero 2007) and the epapose nature of its cypselae. *Heptanthus* is distinguished by rosette herbs, solitary, radiate capitula, involucre with 1-2 series of phyllaries, disc florets functionally staminate and pappus composed of fimbriate scales (Panero 2007). The one species of *Greenmaniella*, *G. resinosa* (S.Watson) W.M.Sharp, is herbaceous or shrubby with alternate leaves, radiate capitula arranged in paniculiform cymes, a 1-2 seriate involucre, cypselae with small wings in angles, and a pappus with crown of awns (Panero 2007). *Neurolaena* are recognized as herbs, shrubs or

treelets, with alternate leaves, usually discoid (rarely radiate) capitula arranged in paniculiform or monochasial cymes, a 2-5 seriate involucre, and pappus of bristles in 1-2 series (Panero 2007). *Calea* are characterized by being herbs or shrubs with usually opposite (rarely alternate or whorled) leaves, radiate (sometimes discoid) capitula either solitary or arranged in paniculiform or corymbiform cymes, 2-6 seriate involucre, and pappus of 6-30 scales with entire or erose margins.

Except for a general description of each genus (Panero 2007), there has never been a systematic or phylogenetic study of Neurolaeneae since the tribe was established (Panero et al. 2001). Taxonomic reviews are available for *Enydra* (Snow 1980) and *Neurolaena* (Turner 1982), but no focused study has been carried out in any of the other genera.



Cypselae diversity of the NEUROLAENEAE

Figure 3. Cypselae diversity in the Neurolaeneae. **A.** *Calea* (*Calea jamaicensis* L.). **B.** *Calea* (*Calea caleoides* (DC.) H.Rob.). **C.** *Neurolaena* (*Neurolaena lobata* R. Br.). **D.** *Greenmaniella* (*Greenmaniella resinosa* W.M. Sharp). **E.** *Heptanthus* (*Heptanthus cochlearifolius* Griseb). **F.** *Enydra* (*Enydra sessilis* DC.). Adapted from Robinson (1981) and Sharp (1935).

NEUROLAENEAE diversity



The size of the circles is proportional to the number of species in each genus.

Calea

Calea L. is the most species-rich genus in the Neurolaeneae. There are 154 species in this genus, corresponding to 87% of the diversity in this tribe, half of which occur in megadiverse Brazil.

Calea clauseniana Baker in Serra da Canastra, Minas Gerais, Brazil.
Photo by J.B.A. Bringel Jr.



Figure 4. Diversity of *Calea*, the most species-rich genus of Neurolaeneae (Compositae). **A.** *Calea* sect. *Calea* (*Calea harlingii* H. Rob.). **B.** *Calea* sect. *Monanthoclea* (*Calea paraguayensis* (Kuntze) Deble). **C.** *Calea* sect. *Haplocalea* (*Calea cymosa* Less.). **D.** *Calea* sect. *Lemmatium* (*Calea fruticosa* (Gardner) Urbatsch, Zlotzky & Pruski). **E.** *Calea* sect. *Meyeria* (*Calea triantha* (Vell.) Pruski). Photos: **A,** A. Cerchiai, ; **B,** G. Heiden; **C,** G. A. Reis-Silva; **D,** H. J. C. Moreira; **E,** P. Schwirkowski.

Key to the Genera of Neurolaeneae

- 1a.** Phyllaries 4; pappus absent.....**Enydra**
- 1b.** Phyllaries 5 or more; pappus present
 - 2a.** Pappus elements scales
 - 3a.** Disc florets functionally staminate; pappus elements fimbriate scales.....**Heptanthus**
 - 3b.** Disc florets with functional androecium and gynoecium; pappus elements erose or entire scales.....**Calea**
 - 2b.** Pappus elements bristles or shallow crown with awns
 - 4a.** Pappus elements 30-65 bristles 4–7 mm long.....**Neurolaena**
 - 4b.** Pappus shallow crown with 4 awns up to 0.5 mm long.....**Greenmaniella**

Calea (Figure 4) comprises 87% of species diversity in the tribe. The genus is concentrated in South America, where the highest richness is found in Brazil with 87 species (55 endemics), Venezuela with 33 species (19 endemics), and Colombia with 23 species (11 endemics). Five sections are recognized in *Calea* following Pruski (1998).

Calea sect. *Calea* (Figure 4A) is recognized by umbelliform to cymose capitulescences and pappuses longer than cypselae length (Urbatsch et al. 1986). It contains 52 species that occur across the whole range of the genus. It is the only section that occurs in Central America and the Caribbean, but the center of diversity is Venezuela and Colombia with 39 species - this section and *Calea* sect. *Monanthocalea* (Less.) Pruski (Figure 4B) are the only sections that occur in the Andes. *Calea* sect. *Monanthocalea* (Figure 4B) is characterized by monocephalous or oligocephalous capitulescences on long peduncles, and pappus scales often longer than cypselae (Pruski 1998). It has 33 species with most diversity in Brazil (16 species), but it also reaches the Andes.

Calea sect. *Haplocalea* (Less.) Pruski (Figure 4C) is characterized by whorled leaves, umbelliform capitulescence, and pappus longer than cypselae (Pruski 1998). This section has eight species and has the southernmost distribution. It is more diverse in Brazil and Paraguay, where seven species occur, while the remaining species occurs in Bolivia. *Calea* sect. *Meyeria* (DC.) Benth. &

Hook.f. (Figure 4E) is recognized by cymose capitulescences and a smaller pappus, shorter than the cypselae. The highest diversity is in Brazil, where 40 of 49 species occur. *Calea* sect. *Lemmatium* Less. (Figure 4D) is distinguished by congested corymbiform (rarely cymose) capitulescences and pappus scales smaller than cypselae (Urbatsch et al. 1986). It is the most narrowly distributed section with all the twelve species occurring in southern Brazil. This is the only section for which a taxonomic review has been produced (Urbatsch et al. 1986).

Meanwhile, all other studies published on the genus over the past 40 years refer to regional taxonomic descriptions in floras (e.g., Wussow et al. 1985) and new species, such as *Calea funkiana* V.R. Bueno & G. Heiden the most recently described species (Bueno & Heiden 2021).

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What's all the hype about HybSeq?

A brief history and introduction to target enrichment in Compositae

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Keywords: Target enrichment, high-throughput sequencing, phylogenomics, phylogenetics.

The year was 2010, and the place was the Compositae White Paper meeting in Davis, California, USA. Members of the National Science Foundation (NSF-USA) funded Compositae Genome Project (CGP; Figure 1) had convened in northern California, in the land of grapevines, to present about their progress in developing tools and studying the genomes of comps (crops). It is still unclear how Dr. Vicki Ann Funk caught wind of this meeting at Davis, but she was intent on attending and talking with (educating) this growing group of genomicists studying sunflowers, lettuce, and their relatives, and convincing the attendees that they needed to look beyond crops of the family. Vicki brought along with her a six foot plus (ca. 2 m) poster with the Compositae metatree of Funk et al. (2009) (Figure 2). She posted it outside in the lobby where those in attendance could not help but see the vast diversity and beautiful possibilities of expanding their genomic knowledge and tools to study the evolution of Compositae.

During that trip, Vicki met with Dr. Loren Rieseberg (University of British Columbia) and Dr. John Burke (University of Georgia) who already had extensive experience studying evolution of members of the family. At that 6AM breakfast, I (a postdoctoral researcher with Burke at the time) was asked to come along. Vicki had an idea: apply this “next-gen” thing to studying the systematics and evolution of Compositae. Studies using ITS/plastid markers left many gaps in our understanding of the evolutionary relationships in the family: it was time for more data and a new approach. The three of them, Loren, John,

and Vicki, hatched a pilot project and I would be the hands at the bench and the keyboard. The rest is sort of history (Mandel et al. 2014; 2015; 2017; 2019), well, after a lot of lab trouble-shooting and banging of head on keyboard for the bioinformatics (even with the help of the wiz Dr. Michael McKain, University of Alabama).

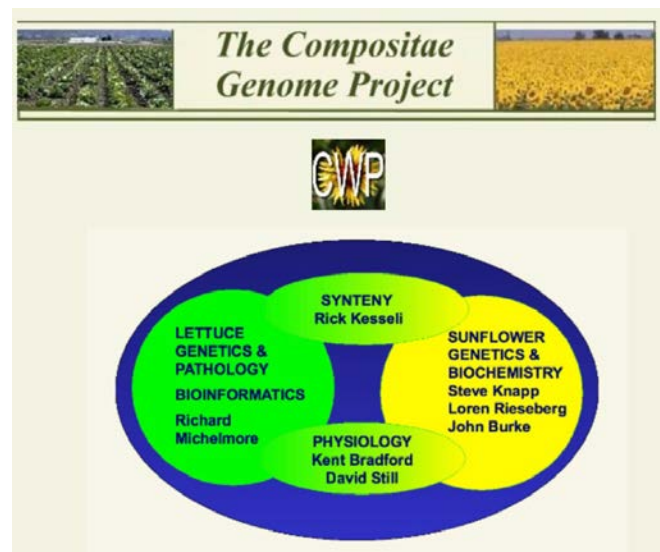


Figure 1. Research facets on the Compositae Genome Project webpage and its Principal Investigators from circa 2000s.

During this time, Vicki introduced Jennifer to Dr. Rebecca Dikow (Research Data Scientist and leader of the Smithsonian Institution Data Science Lab) and the three had a wonderful collaboration through this project and Jennifer and Rebecca continue to collaborate on genomics projects in Compositae.

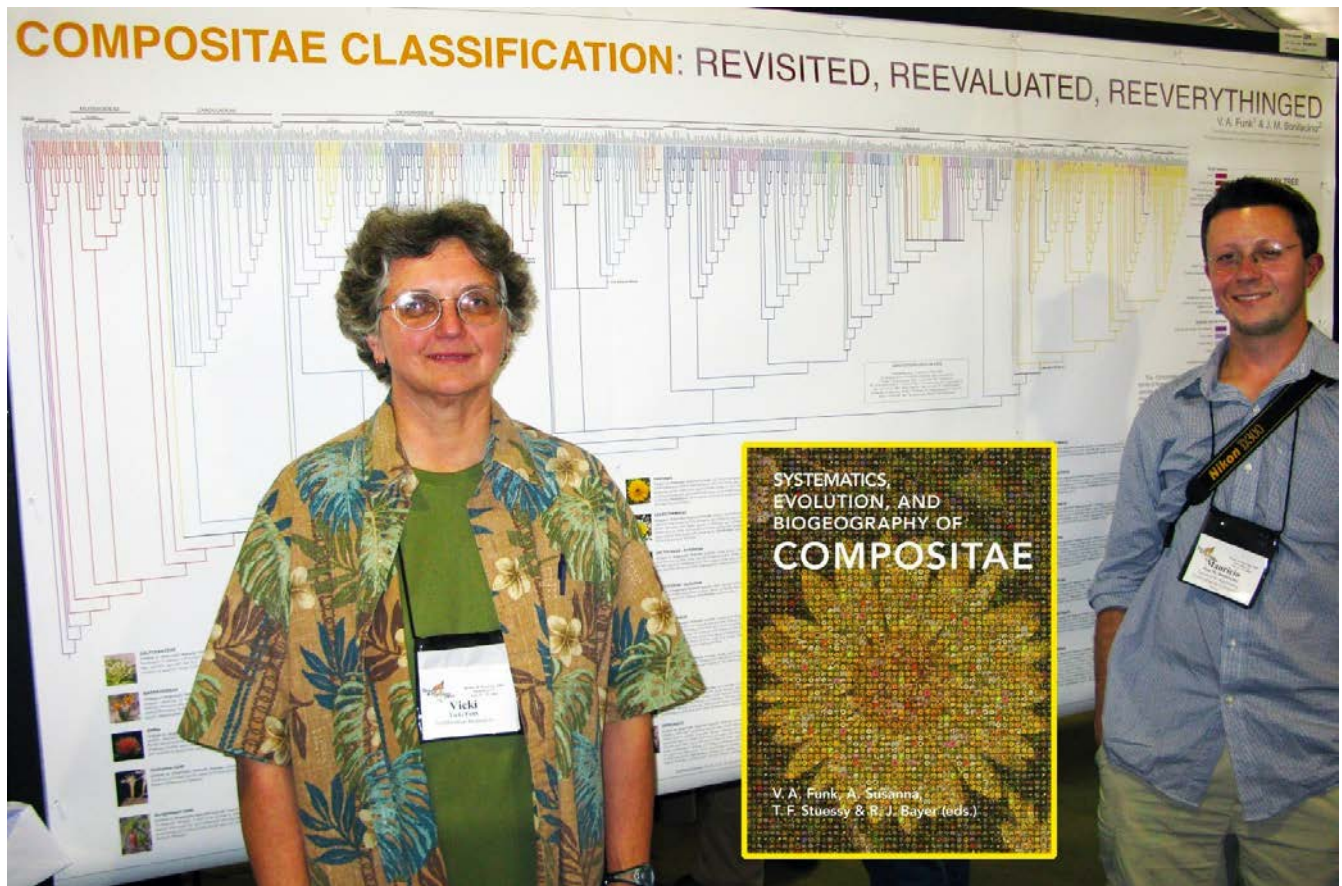


Figure 2. Dr. Vicki Funk with Dr. Mauricio Bonifacino and the huge Compositae metatree.

The great promise of employing big data through HybSeq (aka: target enrichment, sequence capture; Weitemier et al. 2014) to questions of evolutionary relationships are still being seen. This summer, a special issue in APPS (Applications in Plant Sciences) is devoted to “Exploring the Potential of Angiosperms353, a Universal Toolkit for Flowering Plant Phylogenomics” and will highlight the possibilities of phylogenomics with this toolkit for flowering plants. Along with Dr. Carolina Siniscalchi and members of Royal Botanic Gardens at Kew, we present a comparison of the broad toolkit with the Compositae specific kit in, “Lineage-specific vs. universal: comparison of the Compositae1061 and Angiosperms353 enrichment panels in the sunflower family” (Siniscalchi et al. 2021).

The objective of this article is to break down the HybSeq process for the novice, wishing someone had done this for us when we started!

Into the details of HybSeq

Let’s start with the Seq: In 2010, it was clear that massively parallel or so-called next-generation sequencing (NGS) methods were going to radically change the way evolutionary biologists (well everyone in science) would be able to approach research questions. The concept of NGS is that high-throughput sequencing technology can be used to determine the base-pair sequence of DNA/RNA molecules at much larger quantities than previous end-termination based sequencing techniques (e.g. Sanger sequencing). See Ekblom and Wolf’s (2014) fantastic “A field guide to whole-genome sequencing, assembly and annotation” for more details on methods, approaches, and definitions. Briefly, NGS involves sequencing millions of small fragments of DNA (or RNA converted to cDNA) in parallel. While there are several platforms

WET LAB WORKFLOW

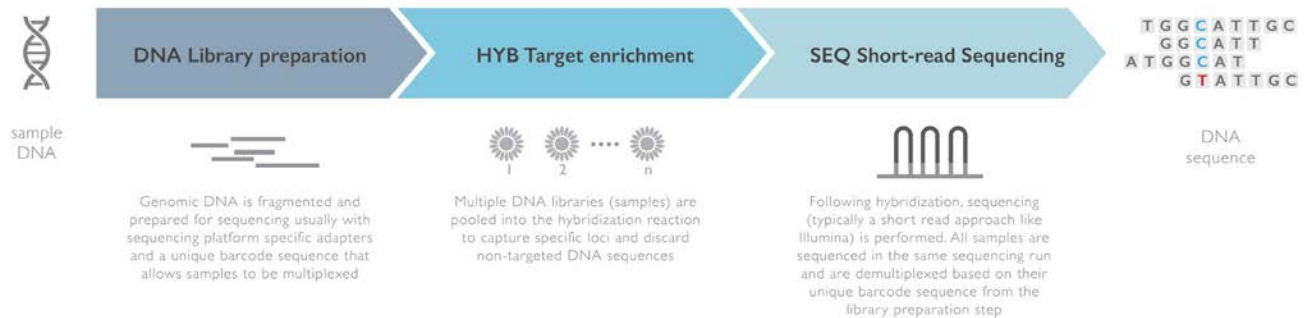


Figure 3. Overview workflow of the HybSeq workflow including DNA library preparation, hybridization of targeted sequences, and high-throughput sequence of captured, or enriched, DNA.

that can accomplish this, the most widely used in studies of phylogenetics and evolution is the Illumina platform. Illumina is ever expanding its sequencing technologies and capabilities, but a few staples are the MiSeq, HiSeq, and more recently the NovaSeq. Sequencing reactions using the Illumina technology take place on the surface of a glass semiconductor (just bigger than a microscope slide) etched with patterned nanowells where the DNA sequencing reactions will occur, called a flow cell. After DNA is extracted, or isolated, from a tissue, the DNA is prepared for NGS sequencing through a library preparation step that involves randomly shearing the DNA and incorporating specific sequences that

allow DNA to adhere to the sequencing flow cell and the sample to be identified. And while fresh tissue usually ends up providing the best library, silica dried, frozen, and herbarium material can be used for successful library preparation and sequencing. Library preparation methods vary in how much time they take to complete, but usually can be performed in 4-6 hours for a single sample and scale nicely as with some training, 96 samples (in plates) could easily be done in a full day. The resulting libraries are quality checked, quantified, and sequenced on the machine. The great part about the library prep step is that you can add a unique barcode, or index, of 6 or more nucleotides to label your

SCHEMATICS OF HYBSEQ PROCESS

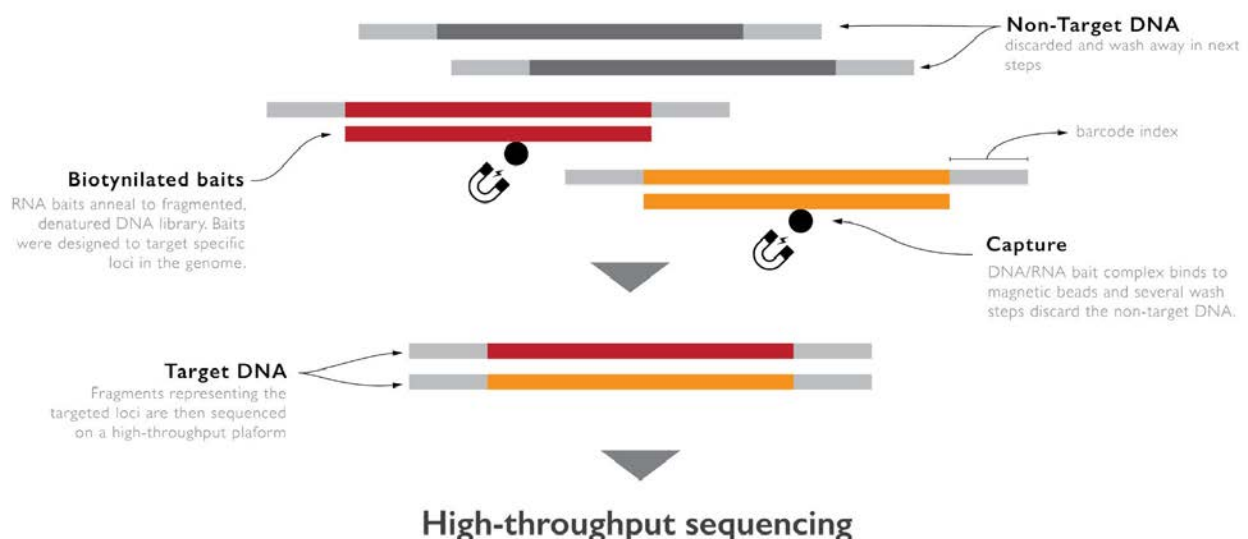


Figure 4. Overview of the hybridization process where targeted genomic sequences are captured using RNA biotinylated baits designed by the user. Non-targeted DNA is discarded during wash steps and the resulting product is a reduced representation of the total genome for sequencing.

individual DNA sample, e.g., *Helianthus annuus* L. might get GACAATTC and *H. verticillatus* Small could get CAACCGAG. The barcode is added near the ends of every single fragment you will sequence. This allows you to pool many samples together on the same flow cell, called multiplexing. Then, the barcode is sequenced along with the rest of the fragment, allowing you to determine which sequenced fragments came from which sample. When the sequencing run finishes, software from the instrument sorts each sequenced fragment into its own directory/folder based upon that barcode, so all *H. annuus* fragments are together in your files.

So, that's the Seq part of HybSeq, what about the Hyb part? The premise here is that instead of sequencing every fragment of DNA from your sample, we target only specific genes. Here, the DNA regions of interest (e.g., 1061 loci for phylogenetics from the Comp1061 MyBaits Kit) are captured or enriched in the sample using long oligonucleotide baits, or probes. The baits are designed to have complementarity to your genes of interest and can be generated de novo (custom captures) or using a pre-designed kit (e.g., Angiosperm353, Johnson et al. 2019; Comp1061). The baits are biotinylated, so they bind to streptavidin-coated magnetic beads; the hybridization is performed in liquid solution in a microcentrifuge or smaller tube. Essentially your DNA (the library you made) sticks to baits, DNA/baits complex sticks to magnetic beads, then you put the tube with the DNA/baits/bead in a magnetic rack stand, wash away all of the DNA fragments that aren't bound to the beads, and elute off the beads, and you've captured your targeted DNA! Since the DNA was randomly sheared during the library prep step, capture fragments overlap and are unique. Most approaches PCR this targeted sample (because it is a very small amount) and then send it for sequencing. That's it! Thanks for reading!

ACKNOWLEDGMENTS

First and foremost, I thank the late Dr. Vicki Ann Funk for her willingness to mentor and work with me for so many years. Her generous and inclusive spirit meant that I was always part of the conversation. It was her idea for using big data to address the evolution of Compositae and I am grateful for her taking me along on the ride. I also want to thank




countless others over the years who have helped us out with the lab work, the bioinformatics, the writing, and the interpretation. Team Compositae is the best!

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Where Linnaeus meets Wallace:

New botanical discoveries highlight the biological shortfalls in the easternmost campos rupestres of Minas Gerais, Brazil

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Keywords: South America, Cerrado, taxonomy, Neotropical mountains.

The concept of biological shortfalls was created to express our deficient knowledge on several aspects of biodiversity. The Linnean shortfall (after Carl Linnaeus, the founder of modern taxonomy) refers to the disparity between named and unnamed species, while the Wallacean shortfall (after Alfred Russel Wallace, founder of biogeography), refers to our fragmentary knowledge on species distribution (Lomolino 2004). Overcoming these shortfalls depends on improving our understanding of species boundaries and increasing collections efforts to cover sampling gaps.

Brazil is home to the greatest plant diversity in the world (BFG 2018), but such rich biodiversity is far from being completely known, as indicated by the number of new plant species described each year in the country. Furthermore, the distribution of this biodiversity is uneven across the vast Brazilian territory. For instance, the campos rupestres, an herbaceous-shrubby vegetation over quartzite or iron ore mountains, cover less than 1% of the Brazilian territory, however, they are home to nearly 15% of the Brazilian plant species, also presenting a high endemism rate (Silveira et al. 2016). Historically, most of the research on campos rupestres has focused on its core area, the Espinhaço Range (ER), a mountain range spanning over 1,000 km in the states of Minas Gerais and Bahia, but less focus

has been given to disjunct areas. Recent botanical and zoological discoveries have demonstrated the occurrence of this vegetation in the historically neglected mountains of the Rio Doce valley, in eastern Minas Gerais.

These mountains form the João Pinto Formation (Figure 1), a set of quartzitic sierras interspersed with granitic inselbergs in the Atlantic Forest Domain. These quartzitic mountains are the Serra do Padre Ângelo (Figure 2) (including Serra do Pinhão), Pico da Aliança, Serra da Onça (Figure 3) and Serra do Boiadeiro (both contained in the Sete Salões State Park) and other smaller fragments around the municipalities of Conselheiro Pena, Alvarenga, and surrounding towns (Oliveira 2000). The first botanical discoveries from these mountains came from “charismatic” families with horticultural interest, such as Orchidaceae and Bromeliaceae, but the area only gained scientific attention after the discovery of the giant carnivorous plant *Drosera magnifica* Rivadavia & Gonella (Droseraceae; Gonella et al. 2015). The botanical expeditions that followed this finding uncovered several new species and records, such as the discovery of new populations of the endangered *Vellozia gigantea* N.L.Menezes & Mello-Silva (Velloziaceae; Mello-Silva 2018) and novelties in Begoniaceae, Eriocaulaceae, Lamiaceae and, most notably, Asteraceae.

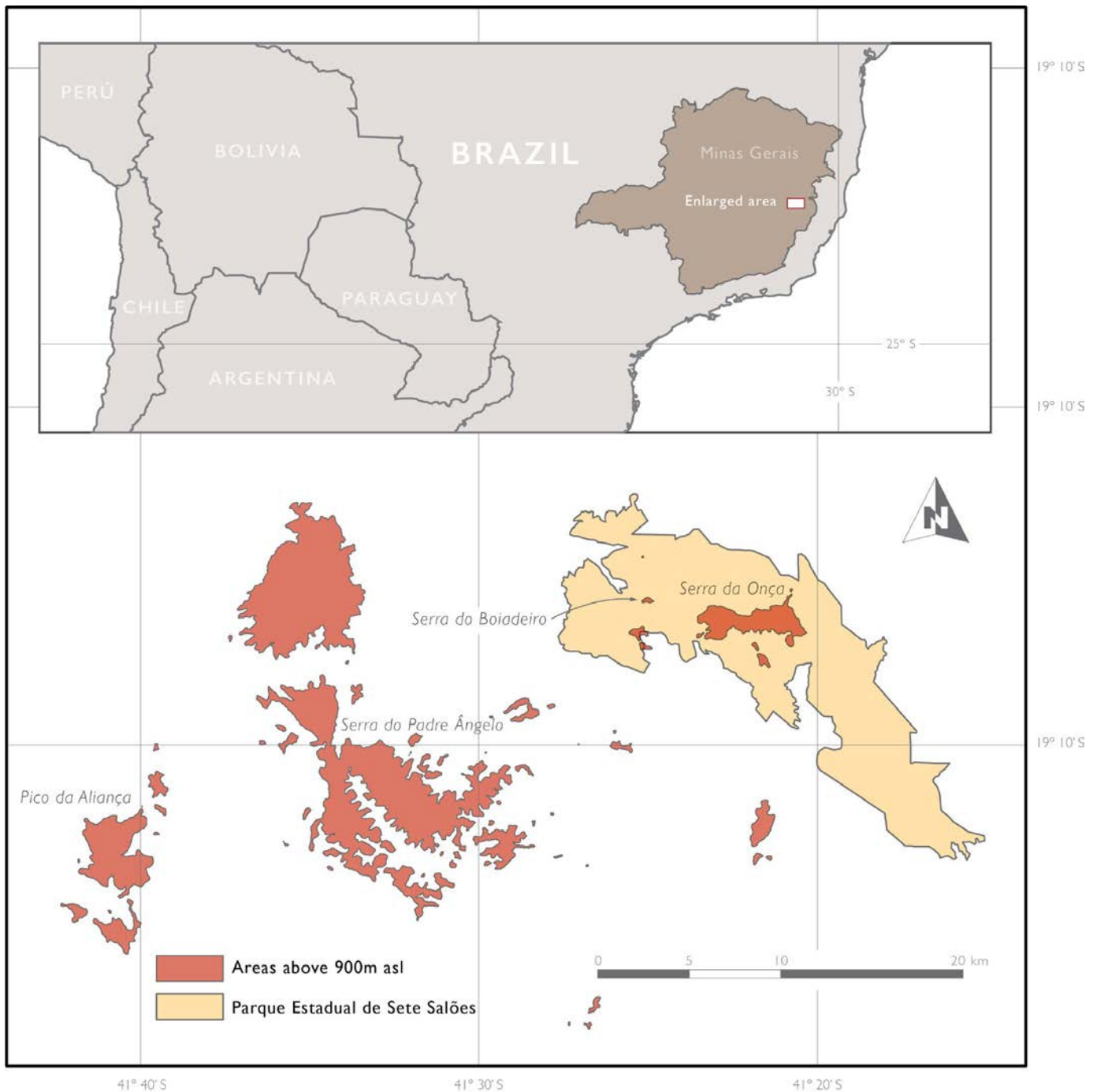


Figure 1. Map showing the location of the mountain areas of João Pinto Formation and the single protected area of the region (Parque Estadual de Sete Salões), in eastern Minas Gerais, southeastern Brazil. The campos rupestres are found within areas above 900 m a.s.l.

Asteraceae is one of the most numerous families in the campos rupestres, with some groups, such as tribe Vernoniae, being especially diverse in this vegetation. The first taxonomic novelties from these mountains, *Chresta filicifolia* Siniscalchi & Loeuille and *Eremanthus ovatifolius* Loeuille & Pirani, belong to this tribe and were described in 2016 from Sete

Salões State Park and Pico da Aliança, respectively (Loeuille & Pirani 2016, Siniscalchi *et al.* 2016). Other novelties came from Pico da Aliança: *Lychnophora haplopappa* Loeuille, Semir & Pirani (Figure 4A) was described in 2019 and *Lessingianthus petraeus* Antar & Loeuille was described in 2021 (Loeuille *et al.* 2019, Antar *et al.* 2021a). Serra do

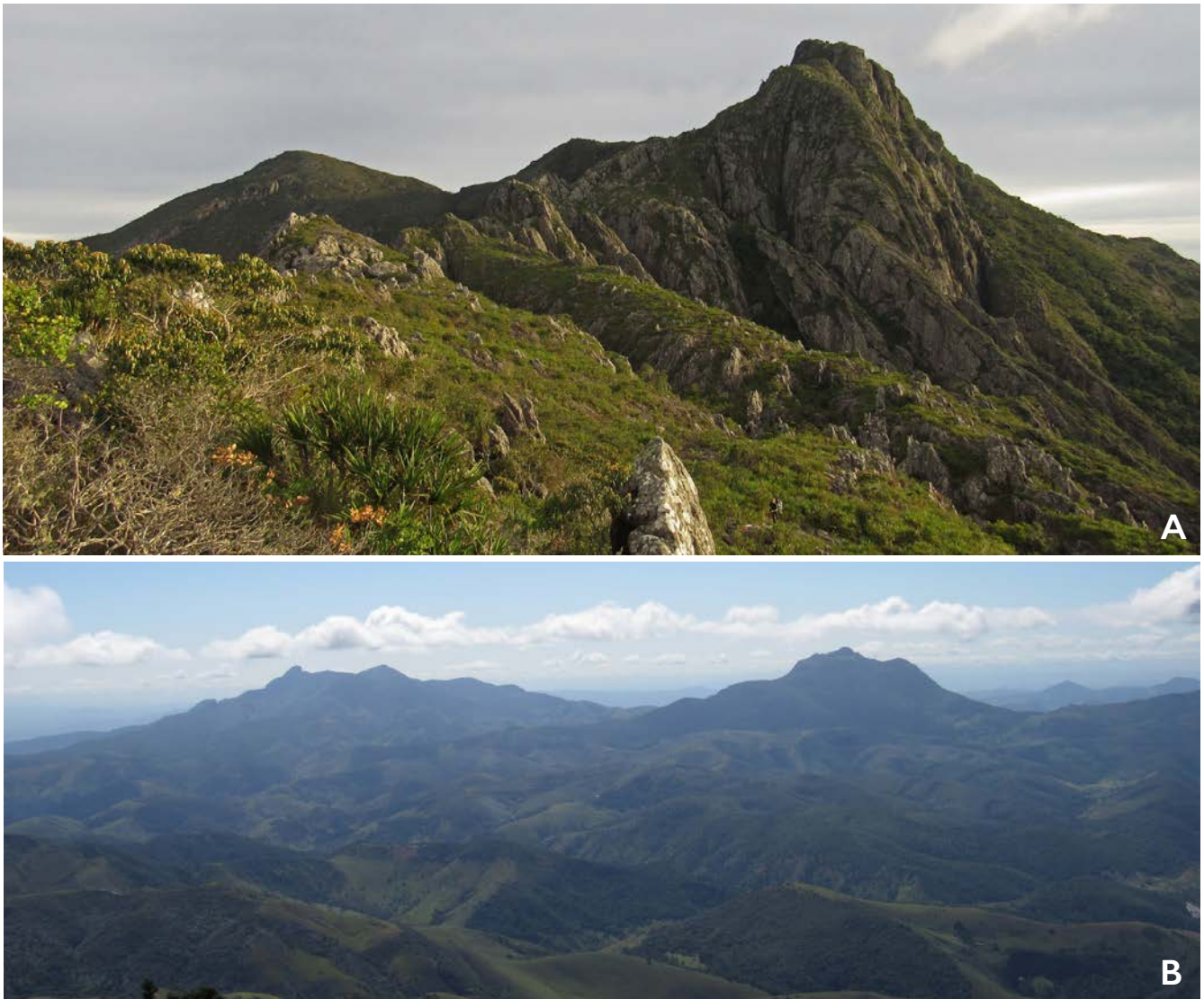


Figure 2. A. The campos rupestres of Pico do Sossego (1605 m a.s.l.), the highest peak of the João Pinto Formation and part of Serra do Padre Ângelo. **B.** The mountain complex of Serra do Padre Ângelo, the massif to the left is the Serra do Pinhão, where Pico do Sossego is located, and the massif to the right is the Pico do Padre Ângelo, whose summit reaches 1547 m a.s.l.

Padre Ângelo revealed another new species: *Lepidaploa campirupestris* Antar & Loeuille (Antar et al. 2021a; Figure 4B). Finally, two *Mikania* Willd. species should receive a name in the near future.

These findings revealed interesting biogeographical patterns, suggesting an interchange of this biota with the core campos rupestres area, ER, located 200 km to the West. Notably, most of the diversity of *Chresta* Vell. ex DC. and *Lychnophora* Mart. is found in the ER, a pattern also seen in other families like Droseraceae (Gonella et al. 2015), Eriocaulaceae (Andrino & Gonella 2021) and Lamiaceae (Antar et al. 2021b).

Other new findings in these areas expanded the known distribution of species previously recorded only in granitic inselbergs, such as *Cololobus rupestris* (Gardner)H.Rob., *Lepidaploa opposita* A.Teles, Sobral & J.N.Nakaj, and *Lessingianthus squamosus* M.Monge & Semir, representing new records for this quartzitic habitat (Antar et al. 2021a). The close proximity of these two rocky habitats in the region may reveal yet other examples of this ecological disjunction.

While the exploration of the region intensified during the last year thanks to the support of a grant from The Mohamed bin Zayed Species Conservation Fund, we have only scratched the surface of the biodiversity of



Figure 3. The campos rupestres of Serra da Onça, protected within the Parque Estadual de Sete Salões. The peak to the left in the background is the Pico do Garrafão (1149 m a.s.l.).



Figure 4. A. *Lychnophora haploppapa* Loeuille, Semir & Pirani, species described in 2019 and endemic to Pico da Aliança. **B.** *Lepidaploa campirupestris* Antar & Loeuille, described in 2021 and endemic to Serra do Padre Ângelo, its epithet refers to its singular habitat, the campos rupestres.

these underexplored mountains. Areas such as Sete Salões State Park remain largely undersampled (only 239 biological records from the area are available in the SpeciesLink database, 160 for plants), and may hide several other novelties. Other areas, like Serra do Padre Ângelo, were severely hit by a wildfire in late 2020 and suffer from the lack of protection. These historically neglected areas should be recognized as priority for biological surveys, to overcome the biological shortfalls, and to ground conservation plans to protect its singular, endemic flora.

ACKNOWLEDGMENTS

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Asteraceae in a megadiverse flora: Results from the Flora of Brazil 2020

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Keywords: Biodiversity, South America, Global Strategy for Plant Conservation, collaborative effort.

The Global Strategy for Plant Conservation (GSPC), established in 2002 by the Conference of Parties, set up a number of targets to decrease the loss of plant diversity, lessen poverty and support sustainable development. The goals of GSPC Target 1 aim to warrant that plant diversity is globally well-understood by 2020. To achieve these goals, Brazil committed to the Flora of Brazil 2020 project (2016–2020) (<http://floradobrasil.jbrj.gov.br>), coordinated by the Jardim Botânico do Rio de Janeiro (JBRJ). It consists of a list of all Brazilian plants, algae and fungi, with short morphological descriptions, identification keys and geographic distributions of all taxa (Figure 1). The flora system also links to a virtual herbarium containing high-resolution images of type collections from large European collections and specimens from several Brazilian herbaria, which can be annotated by experts working on the floristic treatment (BFG 2015, 2018). Sixty-six synantherologists collaboratively prepared the floristic treatment for Asteraceae, under the supervision of Nádia Roque and Jimi N. Nakajima (Roque et al. 2021).

The results from this effort bring into light the importance of Asteraceae in the context of one of the world's richest floras (Roque et al. 2017). The family is the third most diverse in Brazil, being represented by 27 tribes, 326 genera (85 monospecific) and

2,205 species (95% native) and 1362 are endemic to Brazil. Compared to the first two richest families, Fabaceae and Orchidaceae, Asteraceae has the largest number of endemic genera (71). The tribes Eupatorieae Cass. (611 spp.), Vernonieae Cass. (485 spp.), Astereae Cass. (245 spp.) and Heliantheae Cass. (220 spp.) are the richest in number of species, representing approximately 71% of the family diversity.

The Brazilian territory is covered by six phytogeographical domains: Amazon forest, Atlantic forest, Cerrado, Caatinga, Pantanal and Pampa. Asteraceae is the most species-rich family in the Cerrado and Pampas and is within the top five species-rich family in all domains except the Amazon (BFG 2015). The Cerrado and Atlantic Forest, which are both considered biodiversity hotspots (Myers et al. 2000), present the highest absolute number of species of Asteraceae (Figure 2).

The Cerrado, or the central Brazilian savanna, presents two vegetation strata: a medium to low stature arboreal layer, consisted of scattered, fire-resistant trees with contorted trunks and branches, usually with a thick and corky bark, and a herbaceous layer, where Asteraceae predominates along with several species of grasses. Asteraceae is represented by 191 genera and 1,246 species in this domain,

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Angiosperms

Asteraceae Bercht. & J.Presl

Vernoniae Cass.

Piptolepis Sch.Bip.

Piptolepis oleaster (Mart. ex DC.) Sch.Bip.

has as a syn. Vernonia oleaster Mart. ex DC.



has as a syn. Vernonia maritima Gardner

has as a syn. Piptolepis maritima (Gardner) Sch.Bip.

has as a syn. Vernonia buchelliana Gardner

List of names: Angiosperms, genus = PIPTOLEPIS, species = OLEASTER, Show as
to > subp. hier. Search Time: 1.88 sec.

Information Images Voucher


Piptolepis oleaster (Mart. ex DC.) Sch.Bip.  

Accepted Name, Correct name

Taxonomic Hierarchy

Flora → Angiosperms → Asteraceae Bercht. & J.Presl → Vernoniae Cass. → Piptolepis Sch.Bip. → Piptolepis oleaster (Mart. ex DC.) Sch.Bip.

Images from the field



Published by: Benoit Francis Patrice Loeuille
Author: J. Bonfim e Cláudio
Date of inclusion: 16/12/2020 - 10:06:44

Relevant Synonyms

has as a synonym

basonym Vernonia oleaster Mart. ex DC.
heterotypic Piptolepis maritima (Gardner) Sch.Bip.
heterotypic Vernonia buchelliana Gardner
heterotypic Vernonia maritima Gardner

Life Form and Substrate

Life Form
Shrub

Substrate
Terrestrial

Description with controlled fields


Leaf: leaf length more than 1 cm; leaf width more than 5 mm; shape limb ellipticoblanceolate/lancoolate; limb glaucous non; margin flat; surface side adaxial velutinous. Inflorescence: type solitary head/pseudoglomerate of the head. Flower: number of the floret more than 14. Fruit: furrow of the cypsela glabrous or glabrescent; number of the pappus series 2; size of the series of the pappus equal.


Free description

EN

Piptolepis oleaster is easily distinguished from P. campestris by its leaves usually exceeding 3 cm long (vs. never exceeding 3 cm) and its greenish to brownish indument on adaxial surface (vs. silverish canescent).

Vouchers

G. Gardner, 4754, K  Typus
C.F.P. Martius, 543, M, P



See more images

Origin

Native

Endemism

Is endemic from Brazil

Distribution

Geographic distribution

Confirmed occurrences


Southeast (Minas Gerais)

Phytogeographic domains

Central Brazilian Savanna

Vegetation Type

Highland Rocky Field



Link to this taxon

http://services.brj.gov.br/flora/search/Piptolepis_oleaster

Reference

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Administered by the Institute of Research Rio de Janeiro Botanical Garden
Developed by CONICTO-UFPA




  

Figure 1. Flora of Brazil web portal. Sample page of the type of information available at the species level.

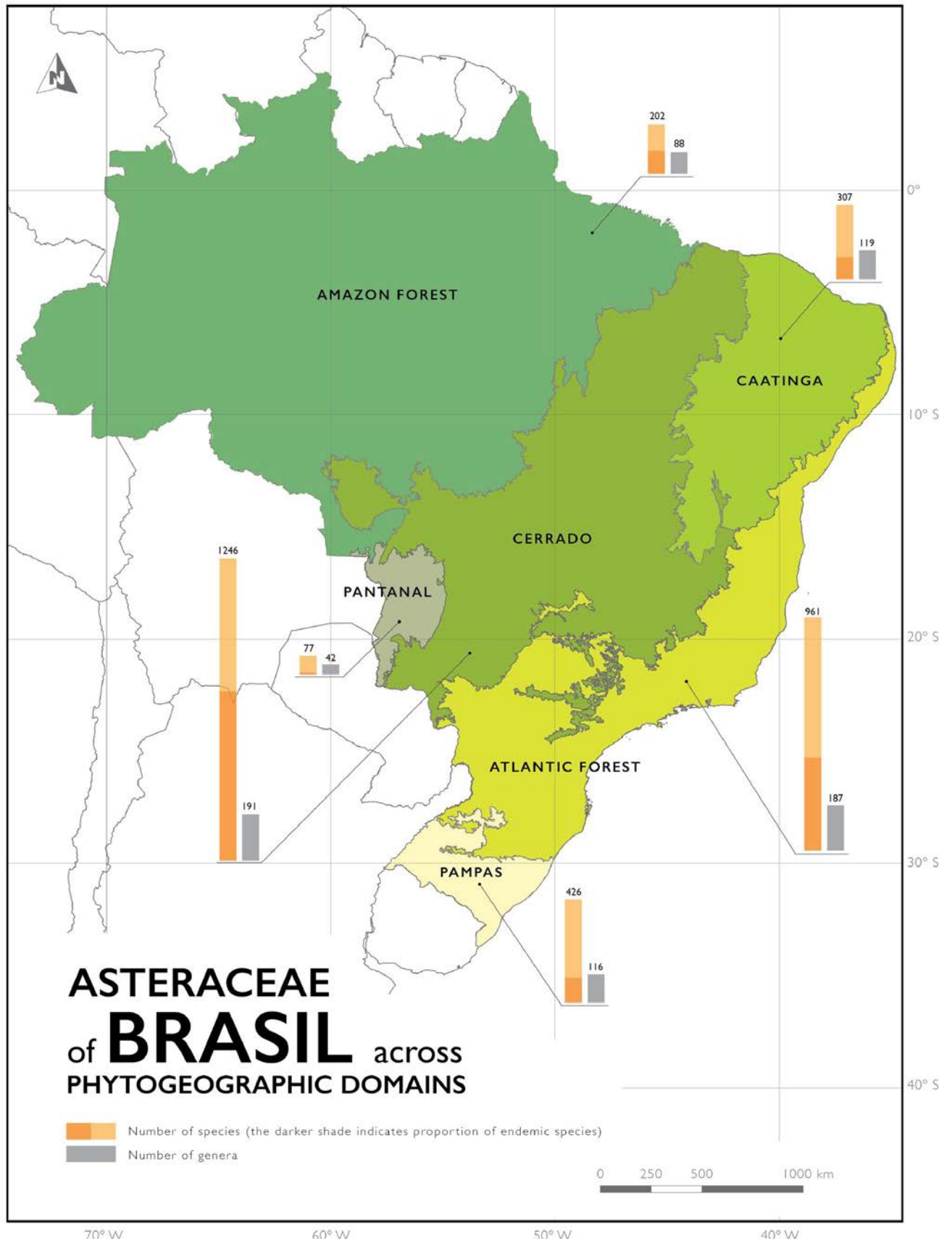


Figure 2. Asteraceae diversity and endemism across phytogeographic domains.

Wunderlichia

Wunderlichia Riedel ex Benth. is a genus endemic from Brazil that comprises five species, three of which are deciduous trees up to 6 meters tall. The species shown here, *Wunderlichia mirabilis* Riedel ex Baker is locally known as *pau-com-flor* (“stick with flower”).



Wunderlichia mirabilis in Licínio de Almeida, Bahia, Brazil.
Photo by Nadia Roque



Figure 3. *Mikania* Willd., the largest genus (199 spp.) in the Brazilian flora. **A.** *Mikania cordifolia* (L.f.) Willd., showing typical climbing habit for the vast majority of the species in the genus. **B.** Close up of head of *Mikania anethifolia* (DC.) Matzenb., showing one of *Mikania*'s defining traits, i.e. 4-floret heads. Photos: M. Bonifacino.

695 of which endemic (Figure 2). Some of the more diverse genera are *Aldama* LaLlave & Lex. (33 spp. – 92% of the genus species), *Eremanthus* Less. (19 spp. – 86%), *Lessingianthus* H.Rob. (98 spp. – 85%), *Calea* L. (68 spp. – 80%), *Aspilia* Thouars (52 spp. – 80%; Figure 4E), *Chromolaena* DC. (45 spp. – 65%), *Lepidaploa* (Cass.) Cass. (34 spp. – 61%). *Soaresia* Sch.Bip. (one sp.), *Pseudostiffia* H.Rob. (one sp.; Figure 4C), and *Staurochlamys* Baker (one sp.) are examples of monotypic endemic genera.

Lychnocephalus Mart. ex DC. an endemic genus with four species (Figure 4D) and *Trichogonia* Gardner, 14 species from 20 are endemic to Brazil (Figure 4F), are mainly distributed in Cerrado domain.

The Atlantic forest is one of the world's richest biomes and yet notoriously endangered and understudied. This rainforest spans the whole coastal area of the country and presents different physiognomies related to latitudinal and elevation changes. Asteraceae is represented by 187 genera and 961 species in this domain, 383 of them endemic (Figure 2). Genera with climbing habits are well-represented in this predominantly arboreal domain, such as *Mikania* Willd. (123 spp.; Figure 3) and *Piptocarpha* R.Br. (24 spp.). The most numerous genus is *Baccharis* L. (134 spp.), and other representative genera are *Senecio* (47 spp.) and *Stevia* Cav. (17 spp.).

The Caatinga is a mosaic of seasonally dry, deciduous forests occurring in the semi-arid portion of the Northeast region. Due to the long dry season, the vegetation is characterized by a variety of xeromorphic plants, where families like Cactaceae, Bromeliaceae and Fabaceae are abundant. Asteraceae is represented by 119 genera and 307 species, of which 12 genera and 92 species are endemic (Figure 2). Many small or monotypic genera are restricted to this domain, such as *Blanchetia* DC., *Caatinganthus* H.Rob., *Mattfeldanthus* H.Rob. & R.M.King and *Piqueriella* R.M.King & H.Rob. The most species-rich genera are *Mikania* and *Baccharis* (23 spp. each) and *Acritopappus* Bercht. & Presl (13 spp.).

The Amazon forest is the largest and most diverse of all tropical forests worldwide, being composed by an archipelago of distinct areas of endemism separated by the major rivers. From the six domains, the Amazon is where Asteraceae presents one of the lowest numbers of recorded species (88 genera/202 species), but 94 of them are endemic (Figure 2). These including five genera from Stiffitiae D. Don (*Eurydochus* Maguire & Wurdack, one sp.; *Glossarion* Maguire, two spp.; *Gongylolepis* R.H.Schomb., one sp. and *Neblinaea* Maguire & Wurdack, one sp.) and two genera from Wunderlichieae Panero & V.A.Funk (*Stenopadus* S.F.Blake, two spp. and *Stomatochaeta* (S.F.Blake) Maguire & Wurdack, one sp.). Due to the overall deficit of floristic studies in this domain and their usually stronger focus on arboreal species, it is likely that much of the Asteraceae diversity in the Amazon is still unknown to science.



Figure 4. Asteraceae representatives from Brazil. **A.** *Stiffia chrysantha* J.C.Mikan. **B.** *Trixis glutinosa* D.Don. **C.** *Pseudostiffia kingii* H.Rob. **D.** *Lychnocephalus tomentosus* Mart. ex DC. **E.** *Aspilia eglerti* J.U.Santos. **F.** *Trichogonia villosa* (Spreng.) Sch.Bip. ex Baker. Photos: **A, C,** L. Moura, **B, D, F,** N. Roque, **E** M. Alves.



Figure 5. *lanthopappus corymbosus* (Less.) Roque & D.J.N.Hind, restricted to the Pampas. Photo: M. Bonifacino.

In the Pampas, a domain restricted to the southernmost portion of the country, Asteraceae is represented by 116 genera and 426 species, with 24% (103 spp.) of them being endemic to the Pampas (Figure 2). Some important genera are: *Pterocaulon* Elliott (11 spp. in Brazil, all of them occurring in the Pampas), *Hypochaeris* L. (9 spp.), *Gamochoaeta* Wedd. (15 spp.), *Noticastrum* DC. (7 spp.), *Conyza* Less. (11 spp.) and *Achyrocline* (Less.) DC. (10 spp.). The tribe Astereae represents almost a third of all Asteraceae species in the Southern region of Brazil. Some genera restricted to this region are: *Criscia* Katinas, *Grindelia* Willd., *Hysterionica* Willd., *lanthopappus* Roque & D.J.N.Hind, *Microgyne* Less., and *Schlechtendalia* Less.

The Pantanal domain is the one that presents the smallest diversity of Asteraceae. The family is represented by 42 genera and 77 species in this domain, with eight species endemic to Brazil (Figure 2). *Aspilia*, *Dimerostemma* Cass. and *Calea* species are some representative genera of Pantanal.

Due to this large collaborative effort, the completion of the Asteraceae treatment in Flora of Brazil 2020 was achieved at the end of 2020. The last comprehensive floristic treatment for the family in Brazil was Martius' *Flora Brasiliensis*, published at the end of the 19th century. This treatment offers a unique global picture of the current taxonomic knowledge of the family, besides showing poorly known taxa and geographic areas that need stronger collection efforts, giving us directions for future research. It is also a fantastic tool to aid identification of Asteraceae species or simply to discover the rich diversity of Brazilian Asteraceae.

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What in the whorled:

The rediscovery of *Helianthus verticillatus* Small (Heliantheae) over 100 years later

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Keywords: clonality, conservation, endangered species, whorled sunflower

The whorled sunflower, *Helianthus verticillatus* Small (Heliantheae Cass.), is a federally listed, endangered sunflower species found exclusively in the southeastern United States (Figure 1). It is a diploid ($x = 17$) perennial that reproduces both sexually and asexually by rhizomatous clonal growths in distinct clusters (Edwards & al., 2020; Ellis & al., 2006; Mandel, 2010; Matthews & al., 2002). The species is self-incompatible and insect pollinated which is typical of other members of the genus. *Helianthus verticillatus* is morphologically distinct from other *Helianthus* species in the southeastern United States by having three to four whorled lower leaves, leaves that are nearly sessile to short petiolate, prominent midvein, and yellow disk floret corollas (Matthews & al., 2002). *Helianthus verticillatus* generally grows up to 3 m tall in wet prairie habitats, open floodplains, and wet depressions near the edges of forests in large clonal clumps (Chafin & Owers, 2010).

Helianthus verticillatus was first described by John K. Small in 1898, based on plants collected in Tennessee by Samuel McCutcheon Bain in 1892 (Matthews & al., 2002). The species was not seen again in nature for over 100 years until 1994 when it was rediscovered in Georgia by Richard T. Ware. James R. Allison discovered a second population 3.6 km west of the Georgia population in Alabama in 1997. Then in 1998, Carl Nordman discovered a

third population of *H. verticillatus* in Madison County, Tennessee, only 10 km northwest from where Bain originally collected the type specimen. In 2006, a fourth population was discovered in McNairy County, Tennessee by Andrea Bishop. Most recently, additional populations have been discovered in Mississippi (2017) by Darrell Brandon and Virginia (2019) by Chris Ulrey (Figure 2), totaling six known populations of *H. verticillatus* spanning five states.

During much of the time between its description and re-discovery, *H. verticillatus* was thought to be a hybrid or of hybrid origin (Heiser & al., 1969). However, once new populations were discovered and research using both morphological and genetic evidence was carried out, it became clear that *H. verticillatus* is indeed a distinct species. Even so, *H. verticillatus* is considered an unusual, rare species considering it has relatively high levels of genetic diversity at both the population and species levels (Edwards & al., 2020; Ellis, 2006; Mandel, 2010), suggesting that it may have historically been more common. Researchers and conservation managers believe that the biggest threats to the known populations are modifications of remnant prairie habitats and the loss and degradation of habitat (Chafin & Owers, 2010; USFWS, 2014). A recent study has shown that the primary pollinators of this species are bumblebees, carpenter bees, and sweat bees (Strange & al., 2020); however, some of

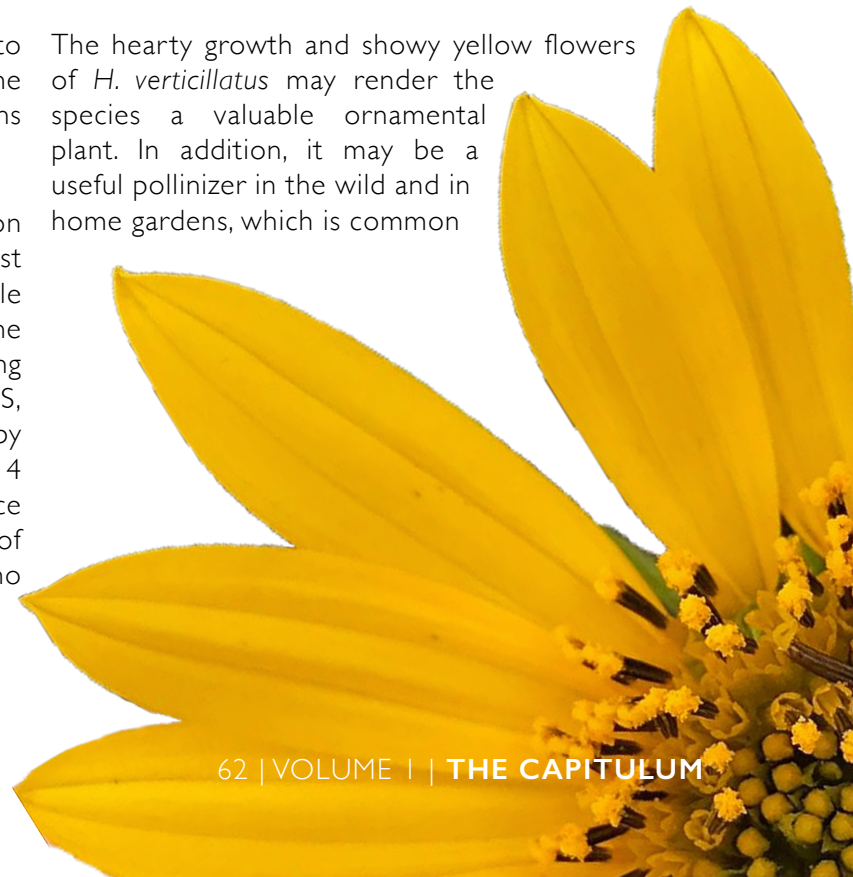


Figure 1. *Helianthus verticillatus* Small. **A.** Close up of heads. **B.** Distinctive whorled leaves. Photos: **A,** C.M. Siniscalchi; **B,** J.R. Mandel.

these bee species only have a flight distance of up to three meters (Schmitt, 1980), greatly reducing the opportunities for gene flow between populations (Loveless & Hamrick, 1984; Edwards & al., 2020).

Having a restricted distribution, small population sizes, and limited sexual reproduction at most known locations make *H. verticillatus* vulnerable to localized extinction. These qualifications led the species to become a candidate for federal listing under the Endangered Species Act in 1999 (USFWS, 1999) and was listed as federally endangered by the United States Fish and Wildlife Service in 2014 (USFWS, 2014). Some actions have been put in place to preserve the populations and limit the effects of habitat degradation, although currently there is no species recovery plan.

The hearty growth and showy yellow flowers of *H. verticillatus* may render the species a valuable ornamental plant. In addition, it may be a useful pollinizer in the wild and in home gardens, which is common



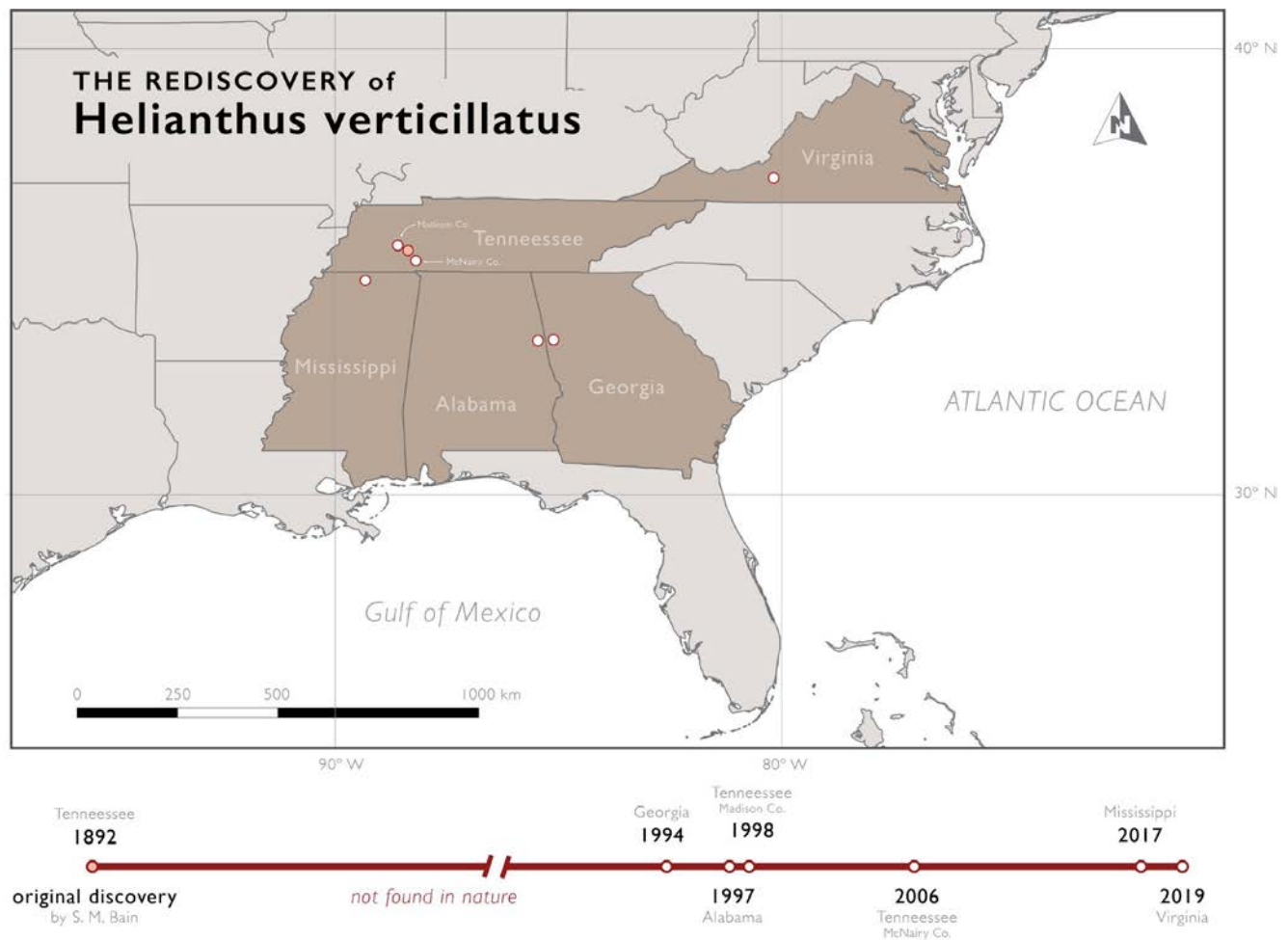


Figure 2. Map showing locations of the six known *Helianthus verticillatus* populations (white circles) and that of the original discovery in 1892 (red circle). The timeline details when populations were discovered.

with other *Helianthus* spp. (Edwards & al., 2020). Its habitat is home to a host of other taxa, some which are considered threatened or vulnerable. Thus, protecting the whorled sunflower is important in preserving biodiversity for both this species and others.

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Ynés Mexía:

Mexican-American Botanist and Trailblazer

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Ynés Mexía was a fearless botanist who traveled to some of the most remote regions in North and South America and collected over 140,000 specimens, including a new genus of Asteraceae.

Ynés Enriquetta Julietta Mexía was born in 1870 in Washington, D.C., the daughter of a Mexican diplomat and granddaughter of a prominent Mexican general (Bracelin, 1938) (Figure 1). Little is known about her early childhood except that she moved frequently, spending her earlier years in Texas and later moving to private schools in Philadelphia and Ontario. She was described as a shy child but enjoyed reading, writing, and spending time outdoors (Anema, 2019; Unladylike2020).

As a young adult, Mexía moved to Mexico to take care of her dying father and help manage the family ranch after he passed away. This period in Mexía's life was marked by many challenges. She married twice; she was widowed shortly after her first marriage and her second marriage ended in divorce after her husband bankrupted the ranch. By her late 30s, Mexía was seriously suffering with her mental health and experiencing mental and physical breakdowns.

In 1909, Mexía moved to San Francisco seeking a fresh start and medical treatment. While recovering in California, she discovered her passion for the



Figure 1. Portrait of Ynés Mexía. Illustration by Dr. Emily Strange.

natural world. Mexía became an early and devoted member of the Sierra Club and Save the Redwoods League, two environmental organizations that were instrumental in fighting for the protection and preservation of nature in the 20th century. She was outspoken about the formation of national parks and efforts to protect the Northern California Redwoods (*Sequoia sempervirens* Endl., CUPRESSACEAE):

I have been much distressed to hear cutting has been going on in Montgomery Grove, I am heartily in sympathy of any effort to save these trees.

Ynés Mexía (Anema, 2019)

Through excursions with the Sierra Club, Mexía traveled across the state hiking and camping in the mountains around Yosemite in the Sierra Nevada and the temperate rainforests of Northern California. These experiences inspired her to return to her studies.

In 1921, Mexía enrolled in an undergraduate program at the University of California, Berkeley. And remarkably, at the age of 51, Mexía began her career in botany. During her studies, she learned how to identify and collect plants, work she described as giving purpose to her life (Unladylike2020). And in 1925, Mexía embarked on her first major field expedition to western Mexico with a group from Stanford University lead by Roxana S. Ferris, assistant curator of the Dudley Herbarium. On that trip, Mexía realized she could accomplish more on her own, so she broke off from the group and proceeded to collect 3,500 specimens from 500 species before returning to California.

For the next thirteen years, Mexía traveled across North and South America becoming one of the most prolific and renowned collectors of her time. As her reputation grew, she was sponsored to lead her own expeditions to some of the most remote regions of the Americas. In 1928, she traveled up to Alaska and made the first general collections in what would become Denali National Park. Between 1929 and 1932, she traveled 4,800 km up the Amazon via steamboat and dugout canoe, following the river to

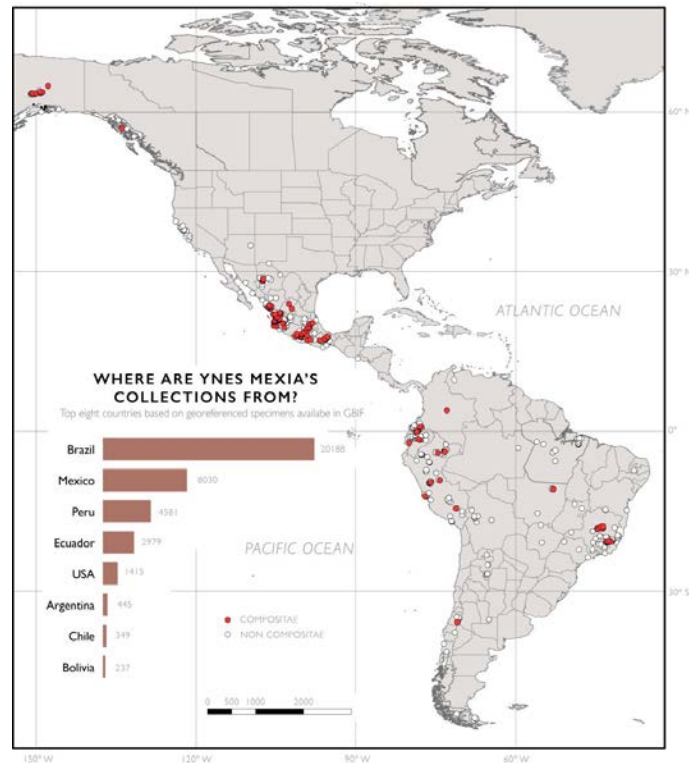


Figure 2. Map of Ynés Mexía's collections across North and South America. Note: map only displays the 7,777 georeferenced occurrence records digitally available of her 140,000+ specimens. Data sources: Bionomia and GBIF.

its source in the Andes mountains (Mexia, 1933). On this major achievement, she crossed South America at its widest point and collected 65,000 specimens in a period of two and a half years.

Over her short career in botany, Mexía traveled from the northern reaches of the Americas down to the southern tip at Tierra del Fuego making stops in

I decided that if I wanted to become better acquainted with the South American Continent the best way would be to make my way right across it.

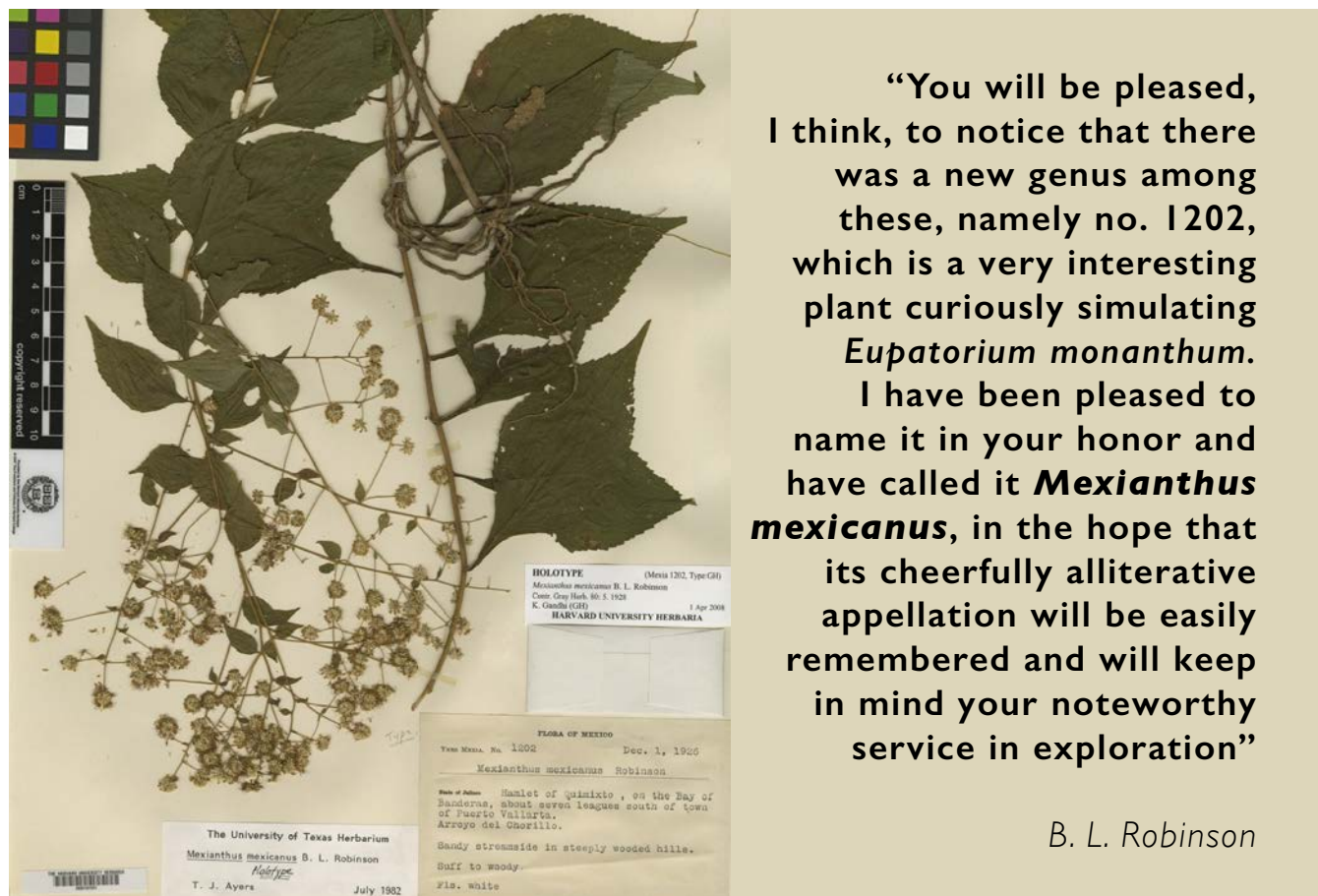
Ynés Mexía (1933)

Alaska, Mexico, Brazil, Peru, Ecuador, Bolivia, Chile, and Argentina (Figure 2), all the while challenging the conventions of what women were capable of in botany at the time.

While Mexía was a skilled generalist collector with a keen eye for new species, through her collections and writing she showed a strong interest in Asteraceae and made significant contributions to research on the family (Mexia, 1929; Bionomia, 2021). Most notably, while doing fieldwork in western Mexico near Puerto Vallarta, she collected a specimen that was later described as a new genus: *Mexianthus mexicanus* B.L.Rob (Figure 3). This specimen was sent for determination among a number of Eupatoriums to Dr. B. L. Robinson, of the Gray Herbarium, Harvard. In addition to a new genus of Asteraceae, Mexía also collected numerous new species: *Acourtia mexiae* L.Cabrera (Figure 4A), *Hofmeisteria mexiae* (B.L.Rob.) B.L.Turner, *Verbesina pantopectera* S.F.Blake, *Verbesina mexiae* B.L.Turner, and many more. However, it was not only new species

It might seem appropriate that in this most remote and hidden nook of this out-of-the-way corner of the world, that I should have collected among other composites one that has turned out to represent a new genus. On December 1, 1926, my mozo, Reyes, and I followed the little river some distance and took a trail that wound up the steep forested volcanic mountains that here pitch directly down to the ocean. After climbing for two or three miles we came to a small stream, “El Arroyo del Chorillo”, named thus from a little waterfall higher up, and working down this stream a bit collected this plant among others along the sandy streambed. It grows to about a meter in height, is suffrutescent to woody below and has small globular heads of white flowers.

Ynés Mexía (1929)



“You will be pleased, I think, to notice that there was a new genus among these, namely no. 1202, which is a very interesting plant curiously simulating *Eupatorium monanthum*. I have been pleased to name it in your honor and have called it ***Mexianthus mexicanus***, in the hope that its cheerfully alliterative appellation will be easily remembered and will keep in mind your noteworthy service in exploration”

B. L. Robinson

Figure 3. New genus of Asteraceae collected by Mexía: *Mexianthus mexicanus* B.L.Rob. Specimen image courtesy of Gray Herbarium of Harvard University.

“I don’t think there’s
any place in the world
where a woman can’t
venture alone.
In all my travels I’ve
never been attacked
by wild animals, lost
my way or caught a
disease.”

Ynes Mexia,
The San Francisco News, 1937



Figure 4. Specimens collected by Ynés Mexía. **A.** *Acourtia mexiae* L. Cabrera. **B.** *Espeletia pycnophylla* subsp. *angelensis* Cuatrec. Specimen images courtesy of **A**, Herbarium of Arnold Arboretum of Harvard University; **B**, United States National Herbarium (US).

of Asteraceae that caught Mexía’s attention. While on an expedition in Ecuador searching for the wax palm (*Ceroxylon ventricosum* Burret), she had a memorable first encounter with *Espeletia* Bonpl., also known as Frailejones (Mexia, 1937). One night of the expedition, Mexía and her guides had to make camp on the páramo near Volcán Chiles. The ground of the campsite was boggy and wet, with constant cold rain coming down. The team quickly built a make-shift camp and windbreak out of Frailejones leaves. The next morning they carried on with the expedition, but not before making an *Espeletia* collection (Figure 4B). Even in the face of challenging conditions, Mexía always showed great resilience and joy in fieldwork.

By the end of her career, Mexía had collected over 140,000 specimens, which contributed to more than 500 newly described species. Today, at least 50 species are named in her honor. She was a fierce conservationist and made many contributions to the early environmental movement in the US. Mexía’s legacy extends beyond her immense contributions to botanical research and conservation. She thrived as a woman in science even after struggling with her mental health and overcoming several personal tragedies. What’s more, her illustrious career as a botanist began in her fifties. Mexía defied society’s expectations, blazing a trail for diverse future generations of botanists.

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In pursuit of *Layia* DC. (Madieae): Unexpected insights from field work in the land of little rain

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When telling colleagues and friends you'll be out in the field collecting wildflowers for a couple weeks, they imagine you leisurely walking in the fields, taking in the sights and sounds, and occasionally stopping to pick sunflowers and daisies. Sometimes fieldwork does actually work out this way, but usually the leisurely moments are far outnumbered by the times when you feel uncomfortable, tired, or caught off guard by unexpected obstacles. Some of the most amazing field work experiences happen when everything completely falls apart, though, even in catastrophic, almost comedic ways, and yet still leads to unanticipated, mind-blowing scientific discoveries. This was the case with our recent field work (Figure 1) as part of research into the whole genome phylogeography of *Layia glandulosa* Hook. & Arn., a state-funded project that was approved in the spring of 2020, just before the world fell apart.

Layia glandulosa (Figure 2) is the most geographically widespread self-incompatible annual in the tarweed and silversword tribe (Madieae Jeps.). It has been the subject of evolutionary studies of speciation in the past for its peripatric progenitor-derivative species relationship with the narrowly endemic serpentine specialist species *Layia discoidea* D.D. Keck. It turns out that *L. discoidea* is nested within *L. glandulosa* in phylogenetic analyses, suggesting that

despite being so morphologically distinct that it was previously placed in a separate tribe, *L. discoidea* is the recent derivative of a presumably extreme natural selection event. We sought support in 2019 to investigate in greater detail the evolutionary history of this fascinating species complex and to use whole genome data to understand the dynamics of budding speciation. As part of our proposal, we promised to collect 100 spatially separate populations of *L. glandulosa* and *L. discoidea* across their ranges in California. *Layia glandulosa* is a common and sometimes abundant part of the ephemeral wildflower blooms that carpet cismontane and desert habitats in California after rain, so as long as there was some precipitation, we did not feel that meeting our goal of 100 populations was an unrealistic promise.

Covid-19 reached California soon after the beginning of 2020 and community spread led to the shutdown of normal life just as the spring wildflowers were beginning to bloom. Of course we canceled our plans to collect *L. glandulosa* in spring 2020 rather than increase the risk of transmission of coronavirus, and were forced to watch the *Layia* DC. blooms from afar through posts on iNaturalist. We told ourselves we would have another chance in spring 2021 to do our field work, without risk of putting more

May your trails be
winding, crooked,
lonesome, dangerous,
leading to the most
amazing view.

Edward Abbey



Our trusty old field vehicle looks young when parked along the path to the ancient bristlecone pine forest (*Pinus longaeva* D.K. Bailey); these trees may be ~4,800 years old, the oldest known individuals of any species.

Photo by Armin Adley

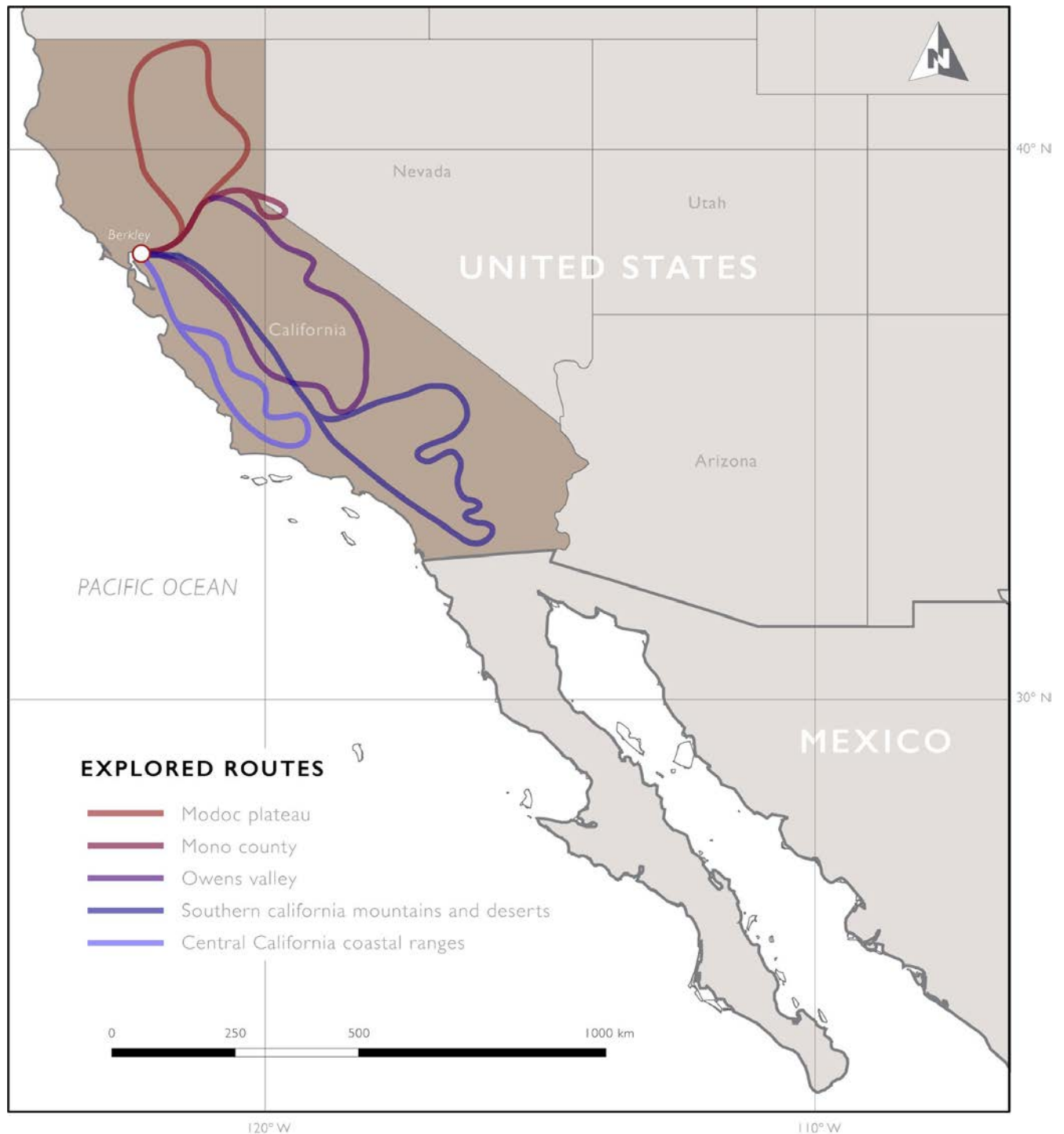


Figure 1. Approximate routes followed in search of *Layia* DC.

pressure on an already stressed healthcare system. Nature had other plans, though. Climate change hit California hard in the summer of 2020, with historic widespread heatwaves that ended up producing the highest temperatures on record for the state, 132 degrees in Death Valley National Park. The intense

heat, coming during the driest part of the year in the western U.S. produced a rash of never-before seen dry lightning that ignited over ~6000 fires in one week. While many evacuated their homes or took shelter from the thick blankets of wildfire smoke, lots of national forests in California closed to the



Figure 2. The jewel of California compositae *Layia glandulosa* Hook. & Arn. grows in gravelly or sandy soils where it is an abundant part of ephemeral spring wildflower blooms. The spicy-scented glandular foliage, often dark purple tinted stems, heterogamous heads, and linear, long tapering awl-shaped disk pappus with woolly tufted bases set this species apart from other annual members of the Madieae Jeps. The ray florets can be white, yellow, cream, or lilac-tinged (or lacking in the derivative species *L. discoidea* D.D. Keck)

public, both to minimize potential damage from past fires and to prevent new ones from starting. Field work was looking like a harder prospect than we expected.

The fire season in California usually winds down in November with the arrival of rain, but in the winter of 2020/2021 a La Niña pattern had settled in the Pacific Ocean, and rain just never arrived. A few storms made it our way later in the winter, delivering solid precipitation to coastal sites, but by March, it was clear that we had to contend with one of the driest spring seasons that most botanists in California had witnessed in their lifetimes. Indeed, data from tree rings showed it to be among the six driest years in 500 years. At this point, we began to seriously doubt whether finding 100 populations of *Layia glandulosa* would even be possible, but we had to try!

In a dry year, the search for flowers becomes a much more complicated, slow-paced, and even interesting affair. We learned to recognize topographical micro-environments on the landscape that could have trapped more moisture, dips in the landscape where a decent bloom might be hiding. In the end, luck, rather than strategy was what saved us. One of our collaborators, Dr. Ryan O'Dell, had been paying special attention to *L. glandulosa* over the past ten years and had collected seeds of over 25 spatially distinct populations. Bruce began germinating these in a greenhouse in Berkeley, thinking they may be our only hope, and had success! By any measure, at least we wouldn't totally strike out. We headed to the field in April with low expectations, scouring dry creek beds and the bases of boulders for places where *L. glandulosa* may have germinated.

It was hard, hot, and uncomfortable field work, but there were redeeming moments as well. In the Peninsular Ranges of southern California, where only paltry *Layia glandulosa* could be found, some uncommon desert rarities were doing surprisingly well. These included flowering beavertail cacti

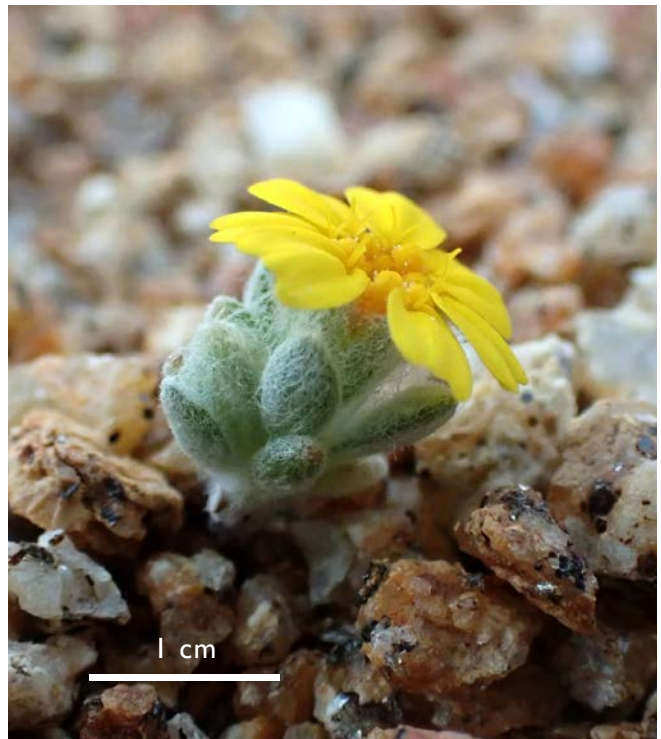


Figure 3. The often tufted, diminutive annual Wallace's woolly daisy (*Eriophyllum wallacei* A. Gray) grows ephemerally in decomposed substrates and can be one of the few plants to bloom in a dry year.

(*Opuntia basilaris* Engelm. & J.M. Bigelow; Cactaceae), carpets of monkeyflowers (*Diplacus bigelovii* (A. Gray) G.L. Nesom; Phrymaceae), and the tiny threadplant (*Nemacladus rubescens* Greene; Campanulaceae), which harbors crystal structures within its diminutive flower that are presumably useful for attracting pollinators (Figure 5). Some interesting and very drought-resistant Compositae were in bloom, too, including members of the tribes Cichorieae (*Calycoseris parryi* A. Gray; Figure 6) and other tarweeds (*Lagophylla ramosissima* Nutt.; Figure 7), and the tiny *Eriophyllum wallacei* A. Gray (Figure 3). Shrubby composites in the genus *Ericameria* Nutt. were having an OK year, with *Ericameria linearifolia* (DC.) Urbatsch & Wussow lighting up the hillsides. Coastal parts of southern California had fared better than other parts of the range of *L. glandulosa* in terms of

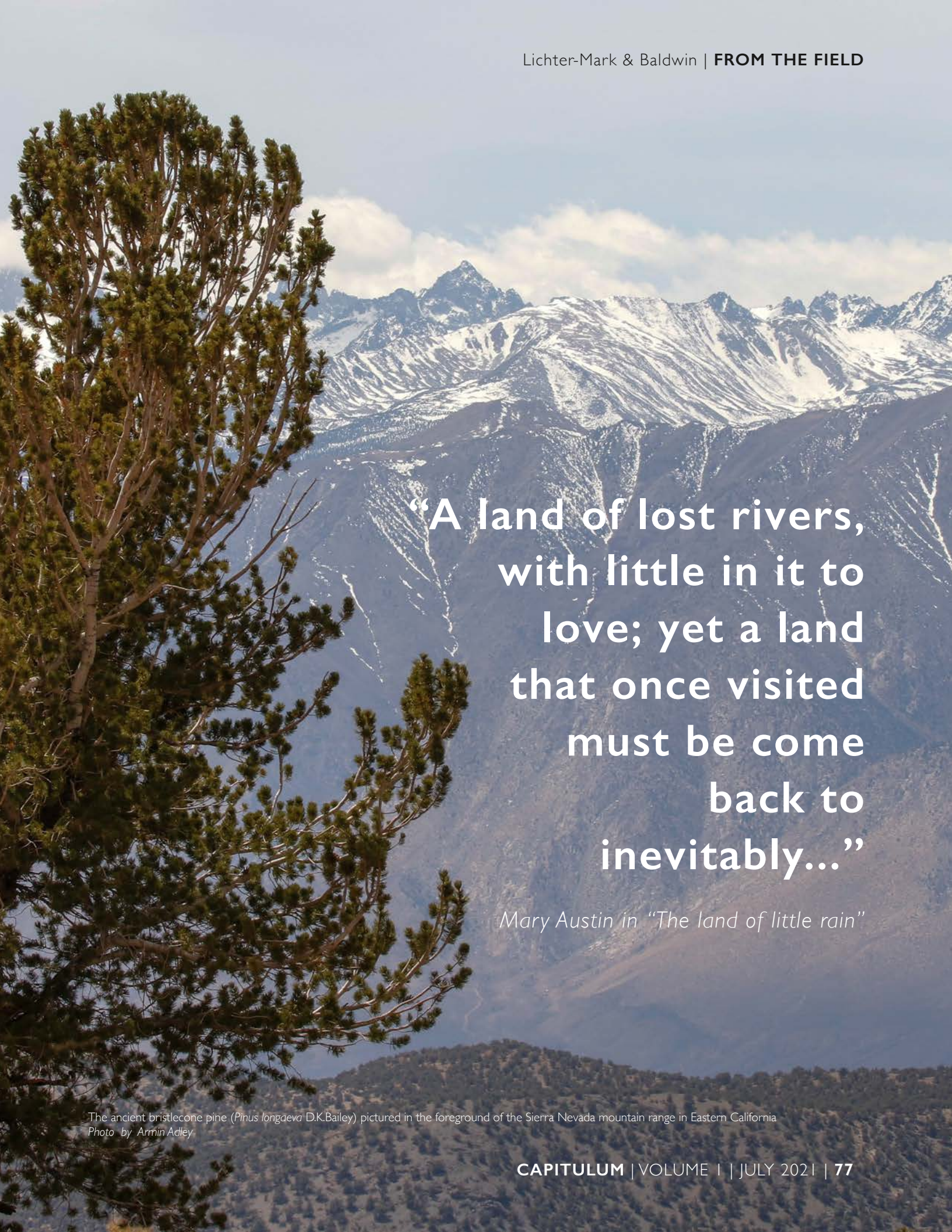
total rain, and we had good luck in collecting plants from the rocky hillsides of the Coast and Transverse ranges. There, *L. glandulosa* shows its greatest amount of variability in flower color, including individuals with yellow, white, cream, or even pink to deep rose ray corollas. These trips were not without mishaps of their own, though, including run-ins with disgruntled property owners, belligerent authorities, and smelly hitchhiking Pacific Crest Trail hikers. Two large rattlesnakes made appearances on our field trips, startling us but inflicting no harm. On one trip, the back of a pickup truck was left open by mistake and all of the plant presses and camping gear ended up spread across the highway! Thanks to a quick search party response and some local desert dwelling do-gooders, everything was recovered intact. We were surprised by our success



Figure 4. Dome fire in Mojave National Preserve was a catastrophe, burning over a million Joshua Trees (*Yucca schidigera* Ortgies, Asparagaceae) in a site deemed refuge for these plants under increasing climate change. In the scar of the burn during a spring without rain, we were surprised to find dense blooms of annual plants, including *Layia glandulosa* Hook. & Arn., among the charred remains of the woodland.



Figure 5. Desert rarities other than comps. **A.** Mojave Kingcup cactus (*Echinocereus triglochidiatus* ssp. *mojavensis*). **B.** *Nemacladus rubescens* Greene (Campanulaceae) is a tiny desert wildflower that contains shiny crystal-like structures that presumably serve to attract curious pollinators to these otherwise invisible little plants. **C.** Bigelow's monkeyflower (*Diplacus bigelovii* (A.Gray) G.L.Nesom; (Phrymaceae).



“A land of lost rivers,
with little in it to
love; yet a land
that once visited
must be come
back to
inevitably...”

Mary Austin in “The land of little rain”

The ancient bristlecone pine (*Pinus longaeva* D.K.Bailey) pictured in the foreground of the Sierra Nevada mountain range in Eastern California
Photo by Armin Adley



Figure 6. Yellow tack-stem (*Calycoseris parryi* A. Gray; Cichorieae) grows in low gravelly areas. **A.** Lateral view of the head. **B.** Close up of the conspicuously dotted stem with tack-shaped glandular trichomes.



Figure 7. The hare-leaf (*Lagophylla ramosissima* Nutt.) is a self-compatible annual tarweed (Madieae) with soft-hairy leaves, fan shaped rays, and yellow to golden brown glands that are attractive to look at but occasionally cause dermatitis on contact.

early on in finding plants, by May we (Figure 9) had found about 70 populations of *L. glandulosa* despite the unprecedented drought, but the most difficult part of the species range lay ahead, the Mojave Desert.

The Mojave Desert is the highest and driest of the North American deserts and in many years, precipitation can be negligible or none. In a typical dry year one can still find blooms by looking in the creek beds and low spots, but this year even that strategy would not cut it. On our first visit to the Mojave we checked the low arroyos and found nothing. We checked the bases of boulders and cliffs where the water runs down — nothing. We even checked the ditches along roadsides — still nothing! Finally, in an act of desperation, we visited a popular hiking spot where plants had been posted many times on iNaturalist. The location was along a popular trail on Cima Dome in Mojave National Preserve, but upon arrival we found the entire area had recently been burned to a crisp by a fast moving wildfire known as the Dome Fire. We thought we



Armin Adley (UC Berkeley undergraduate researcher) scouts for *Layia* DC. among the dry granodiorite rock formations of the Alabama Hills in Inyo co., California.



Figure 8. A key member of the collecting team, Rio, helped sniff out rare blooms in a drought year, such as this carpet of goldfields (*Lasthenia gracilis* (DC.) Greene) in the peninsular mountain ranges.

were out of luck, but when we walked the trail, to our surprise, there were flowers everywhere! Apparently, the heat and release of nutrients from the wildfire had stimulated a good wildflower bloom despite the complete lack of water (Figure 4). This was unheard of, since the convergence of drought and wildfire in the desert was such an exceedingly rare occurrence. It was even hard for us to believe. In the middle of a dry, drought-stricken desert with no germination for hundreds of miles we had found an abundance of wildflowers in the charred, blackened scar of a Joshua tree woodland! We found maps of the recent wildfires and burn scars turned out to be productive places to find *L. glandulosa* in other parts of the state, as well, helping us to finally fill out the remainder of gaps in our sampling up to 100 populations.

The global changes occurring now are unprecedented in scale and effect, and we don't have the slightest idea what future conditions will prove conducive for the growth of our plants. Being forced to search for plants in one of the hottest, driest, and most burnt years anybody could remember was challenging,

but it also surprised us. The most unexpected discovery we made was that at the convergence of these multiple disasters, when all hope for finding plants seemed to be lost, in the most unlikely places, wildflowers will still grow.



Figure 9. Part of the collecting team, from left to right: Armin Adley, Rio and Isaac Lichter-Mark.

ACKNOWLEDGEMENTS

The whole genome phylogeography of *Layia glandulosa* project is supported by the California Conservation Genomics Project and our research team was made up of Armin Adley, Susan Fawcett, Ryan O'Dell, Bridget Wessa, and Sophia Winitsky. Thank you to J. Mauricio Bonifacino and the TICA newsletter committee for useful comments on our report from the field and The International Compositae Alliance for lots of inspiration along the way!

STYLE

Where art and science converge



▲ WIRES-AND-WOOL

The image shows *Lemooria burkittii* (Benth.) P.S.Short (Gnaphalieae Lecoq & Juill.). I am attaching this odd-looking arid zone ephemeral, simply because I was very happy to have seen it for the first time during my last family holiday - it had been on my list for some time!
Australia, New South Wales.

Alexander N. Schmidt-Lebuhr

DISTEPHANUS ►

Distephanus populifolius (Lam.) Cass. is a striking example of the Mauritius flora with its blue-silver leaves and golden yellow florets. This endemic species is rare and only found on a handful of exposed mountain tops.

Luis Valente





HELICHRYSUM

Helichrysum devium J.Y.Johnson (Gnaphalieae Lecoq & Juill.)
is endemic to Madeira and grows along
the rocky cliffs on the eastern tip of the island.
I was really happy to see this species, along with several other
island Asteraceae, on a recent short trip in February 2020.

Lizzie Roeble



With the COVID-19 pandemic, many of us saw ourselves isolated from our colleagues, having to change our work routines and suddenly way too familiar with videoconferencing and all the different platforms that our institutions chose to use. In this sometimes weird and worrying reality, some of us synantherologists, mainly based in the USA, started a small online journal club, where we could meet and discuss some of the amazing new research being done around the world. Soon, members began inviting the authors of some papers to participate in the discussion and they, in turn, invited friends from other countries, and as a result, the collective wish to reactivate TICA gained momentum. We then started to discuss what TICA would look like and how it could benefit our global community of Compositae enthusiasts. These initial discussions resulted in the decision of rebooting the Compositae Newsletter in the form of *Capitulum*, which you have in your hands now, and in TICATalks, a series of monthly online seminars. TICATalks was created as a mean of bringing the Compositae community together, reaching researchers all around the globe and showcasing the work being done in the family. After a few months of thinking about a format for presentations and potential speakers, we launched TICATalks in January 2021 and since then have hosted six sessions.

Our inaugural talk ([Figure 1](#)), on January 25th, 2021, was a homage to the late Dr. Vicki Funk, which was a driving force in getting the Compositae community working together and coming up with big questions that still need to be solved regarding the family's evolution. In this session, Dr. Jennifer Ackerfield (Denver Botanic Gardens, USA) gave a short talk about a new species of thistle endemic to the Western USA that is being named in honor of Vicki Funk and gave some updates on her work with *Cirsium* Mill. Dr. Mauricio Bonifacino (Universidad de la República, Uruguay) did a great job in showing how TICA came to be, how the Global Compositae Database is being assembled and what to expect in the near future.

In February, we had a slightly different format, the session having been made up of three talks of approximately 15-minutes. Graduate student Erika Moore (University of Memphis, USA) gave a talk about a rare species of sunflower endemic to the Southeastern USA, as well as about the efforts being made to reevaluate its genetic diversity. Gabriel Johnson (Smithsonian Institution, USA) introduced us to some of the common misconceptions about preservation of tissue for DNA extractions and presented some creative alternatives to silica-gel. Finally, Dr. Bort Edwards (Yale University, USA)

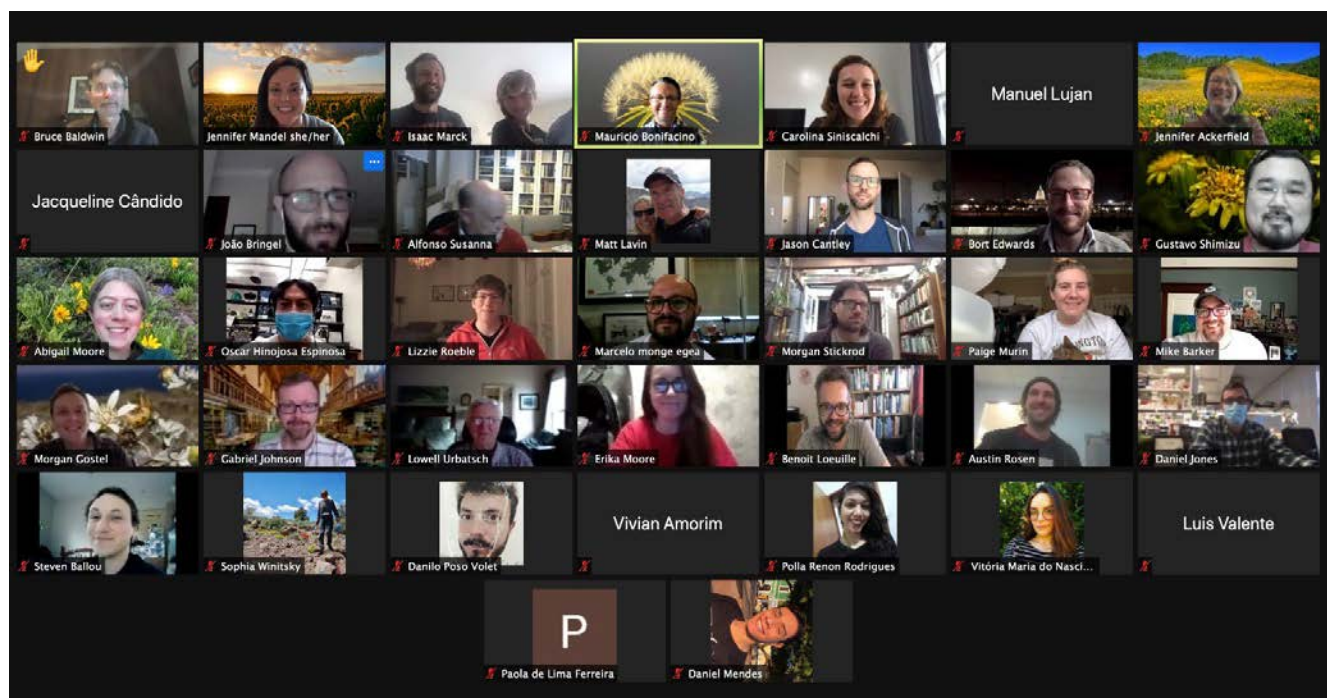


Figure 1. Screenshot of the zoom session of the first Tica Talks held on January 25th 2021.

shared some of his effort in assembling an extensive database of Compositae occurrences and what this data can tell us about Compositae evolution.

In March, we went on a trip around the Americas, listening to field stories and exciting discoveries. In this series of short talks, graduate student Isaac Lichter-Marck (University of California Berkeley, USA) talked about and showed us some of his fieldwork in the Baja California peninsula, which is aimed at systematic studies of the rock daisies from tribe Perityleae B.G.Baldwin. Following Isaac, graduate student Oscar Hinojosa Espinosa (University of California Davis, USA) showed some of the fieldwork he carried out in his studies of the tribe Tageteae and the ethnobotany of Mexican Compositae. Dr. Naomi Fraga (California Botanic Garden, USA) then showed us the exciting and rare Compositae from southern California. Moving from North to South America, Dr. Carolina M. Siniscalchi (Mississippi State University, USA) showed us a small mountain range in Southeastern Brazil, where numerous undescribed species have been found, including at least seven new Compositae taxa. Finally, Dr. Mauricio Bonifacino (Universidad de la República, Uruguay) showed us some of the striking Compositae found in Patagonia and some of the closest relatives to the family, such as Calyceraceae.

In April, we shifted our focus to the Pacific and to some of the efforts being made to understand the local flora. Dr. Tim Gallaher (Bishop Museum, USA) showed us how he and his team are assembling a modern taxonomic system for the e-Flora of Hawaii and using Compositae as a case study. Dr. Jason Cantley (San Francisco State University, USA) then showed some of the efforts he, together with a group of collaborators, is making to understand plant evolution and distributions across the Pacific islands and coasts, including the assembly of Hawaiian flora.

In May, we continued our journey around the globe, this time stopping in Australia. Dr. Alexander Schmidt-Lebuhn (CSIRO, Australia) gave an excellent talk, showing some of the diversity and distribution patterns of Australian Compositae, then presenting some recent work in the systematics of the megagenus *Senecio* L. and the efforts to understand the evolution of tribe Gnaphalieae Lecoq & Juill.

In June, our overarching theme was morphological features of the family. MSc. Erandi Sánchez Chávez (Instituto de Ecología Veracruz, Mexico) introduced us to the climbing genus *Hidalgoa* La Llave and its evolutionary history. Dr. Jorge Crisci and Dr. Liliana Katinas (Universidad Nacional de La Plata, Argentina) presented some of the studies being done about

the striking secondary heads of Nassauvieae Cass. and the direction this exciting research is taking.

Our seminars have had strong attendance, and the recordings of the sessions uploaded to the Compositae Alliance Youtube channel have also been watched many times. We're striving to compile a diverse array of speakers, to truly represent all the research being carried out globally. However, even with our best efforts, most of our talks have been focused on the North-South America axis. We would love to have speakers from Asia and Africa in our next sessions. Our flexible format, including short, medium and long talks, is also ideal to have a mix of ongoing and finalized research presented, which can be beneficial for graduate students looking to present some of their thesis research, for example. We also hope that our frequent meetings will pave the way to organizing an in-person TICA meeting sometime soon.

Our next seminar will be in August 2021, where we'll have a whole session dedicated to the Gochnatieae Panero & V.A.Funk, with talks by Dr. Morgan Gostel (Botanical Research Institute of Texas, USA), Dr. Nadia Roque (Universidade Federal da Bahia, Brazil) and Dr. Gisela Sancho (Universidad Nacional de La Plata, Argentina). In September, we will have Dr. Gustavo Heiden (Embrapa Clima Temperado, Brazil), who will share his studies in the mega-genus genus *Baccharis* L. and how our understanding changed with new phylogenetic hypotheses. Our speakers for October and November have not been confirmed yet, and they could include you! If you are interested in presenting a talk, fill out the form the available in the compositae.org website. We look forward to seeing you next time!

The TICATalks Team

CAPITULUM

THE INTERNATIONAL COMPOSITAE ALLIANCE NEWSLETTER

GUIDELINES FOR AUTHORS

HEAD TOPICS

Section to showcase current research on Compositae. It could be a digest of a paper recently published or a description of a research project among other things. Length of articles could be up to 3000 words.

PIPET & PRESS

Articles about methods and techniques. Length of articles up to 1000 words.

BREVIA

Same scope as in HEAD TOPICS section but not as long. Length of articles could be up to 1500 words.

THE HANDLENS

A close up look to a given species or morphological structure. Length of article up to 1500 words

THE CABINET

A window to the stories behind ancient or recent herbarium samples and the botanists behind them.
Length of articles up to 1500 words

FROM THE FIELD

The place where the bold and the adventurous share their latest finds in their eternal pursuit of the more recalcitrant comps. Length of articles up to 2000 words

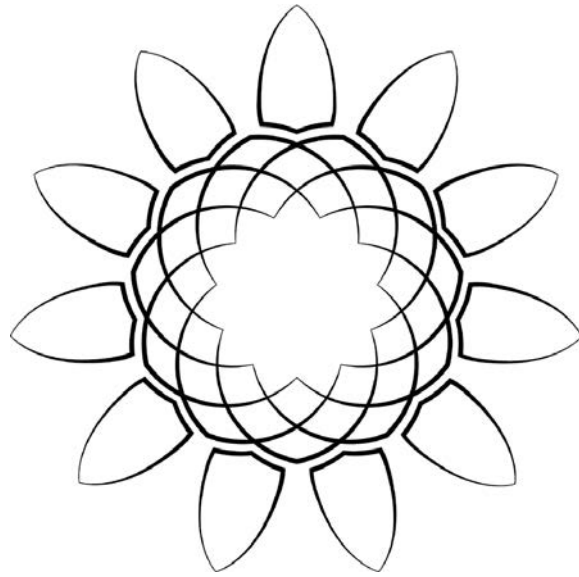
STYLE

Where science and art converge, artistic photography, botanical illustration or creative infographics.
All is welcome if it comes with style.

PREPARATION OF TEXT

Consult a recent issue of CAPITULUM and follow these instructions. Language for submission is English. Contributions are sent two external reviewers. Use Times New Roman/Arial typography. Provide a title and if needed, a subtitle. Include names of all authors and their professional affiliations and emails. Include a list of 5–6 keywords in alphabetical order. There is no set structure on how to organize your text; however you may include the classic I-M&M-R-D or none of these, but you should include Acknowledgements and Literature Cited. Up to two subheading categories are accepted. Keep title and subheadings short and informative. All scientific names at the rank of tribe or inferior should include authorship the first time they appear in the text, following Brummitt & Powell, *Authors of Plant Names* (Kew, 1992; info included in the International Plant Names Index [IPNI]) A single space must follow after a period, colon, semi-colon, or comma. Tables must be prepared using MS Excel, please include different tables as different spreadsheets on the same file. Figures should be provided in either TIFF format (for photos) or as vector graphics such as AI or EPS for diagrams, illustrations or phylogenetic trees. Maps should be provided as shape files when possible or as vector graphics. You may send the photos and other graphics ordered and arranged following your preference but you are advised that we could edit them to adjust them to CAPITULUM style. All figures must be uploaded as individual original files. Photos should be at least 300 dpi in resolution. Literature citation: please check that all your references are cited and vice versa. For the style of references check a recent issue of CAPITULUM.

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are to be submitted at www.compositae.org



Magno amore in familiam Synantherearum captus
Lessing, 1829