# THE FLORIDA ENDEMIC SUNDEW *DROSERA FLORIDANA* ELEVATED TO SPECIES RANK

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Abstract: *Drosera filiformis* var. *floridana* is hereby elevated on species rank to *Drosera floridana* on account of its unique morphology, ecology, and phenology, by which it differs from both the allopatric *D. filiformis* and sympatric *D. tracyi*. An amended description is provided for *D. floridana*, including differential stipule and flower characters presented here for the first time. Its distribution, biology and conservation are discussed, and the species is illustrated in comparison to its two closest relatives. As an additional taxonomic consequence, *D.* × *californica* nothovar. *arenaria*, the natural hybrid between *D. floridana* and *D. tracyi*, likewise must be newly combined to species rank, *D.* × *arenaria*. *Drosera floridana* is the most geographically restricted sundew species of North America, endemic to the Greenhead Slope Lake Region and spanning only two counties in the state of Florida (in contrast to the broad Gulf Coastal plain range of *D. tracyi* and the scattered mid to northern Atlantic Coast distribution of *D. filiformis*). Naturally, *D. floridana* is associated with quartz sand littoral zone seepage areas, a phenomenon exclusive to a small number of oligotrophic lakes in Bay and Washington counties, Florida. *Drosera floridana* does not outcompete *D. tracyi* and resulting hybrids in the absence of its preferred ecotone of intermediate moisture ephemerality between the sympatric congeners *D. tracyi* and *D. capillaris*. In contrast, *D. tracyi* occurs beside *Sarracenia* spp. in wet wiregrass pine savannas, while *D. filiformis* is more generalist, inhabiting *Sphagnum* bogs, late-successional woodland seepages, non-seepage lake littoral zones, and bay rims of clay or sand-based pocosins.

## Introduction

Among the ca. 270 species composing the globally widespread carnivorous plant genus *Drosera* L. (sundews), ten are native to North America, all of which belong to *Drosera* subgenus *Drosera* section *Drosera* (Rice *et al.* 2017; Fleischmann *et al.* 2018a). Three of the four North American endemic *Drosera*, *D. filiformis* Raf. var. *filiformis*, *D. tracyi* (Diels) Macfarl. (syn. *D. filiformis* var. *tracyi* Diels), and *D. filiformis* var. *floridana* B.Rice, as well as their specific hybrids (*D.* × *californica*

Cheek and *D.* × *californica* nothovar. *arenaria* B.Rice), are colloquially known as the "thread-leaf sundews" (see Rice 2011) on account of their long, narrow, filiform leaves superficially resembling fine threads. Among *Drosera* section *Drosera*, the "thread-leaf sundews" are unique in their long, filiform leaves with a petiole reduced to less than one-fifth of the total leaf length at maturity. Additionally, they are the only members within *Drosera* section *Drosera* with woolly stipules that are adnate to the petiole base along their entire length. There are only three other members in the entire genus *Drosera* with similar long thread-like leaves: again, a trio of closely related New World species, yet endemic to Brazil: *D. graminifolia* A.St.-Hil., *D. spiralis* A.St.-Hil., and *D. magnifica* Rivadavia & Gonella (Gonella *et al.* 2015, 2022). Likewise, they belong to the phylogenetically derived *D.* subgenus *Drosera*; however, they belong to the largely Brazilian endemic *D.* section *Brasilianae* (Fleischmann *et al.* 2018a, b).

The taxonomy of the three North American thread-leaf sundews has long been under debate (for a summary, see Schnell 1995; Rice 2011; and Brittnacher 2018). *Drosera filiformis* was originally described by Rafinesque (1808) from Gloucester County, New Jersey and Sussex County, Delaware and was considered the only thread-leaf sundew of North America for almost one century, until Diels distinguished a second taxon of thread-leaf sundew in his *Drosera* monograph (Diels 1906), at that time as an infrataxon of *D. filiformis*: *D. filiformis* var. *tracyi*. The taxonomic rank of these two taxa has been disputed since, whether they should be treated as varieties of *D. filiformis* (as put forward by Diels 1906; Wynne 1944; Wood 1960; Schnell 1995, 2002; Schlauer 1996; Wynne 1944 using the superfluous name *D. filiformis* var. *typica* Wynne for *D. filiformis* var. *filiformis*), or perhaps even better as geographically isolated subspecies (suggested as a “compromise” by Schlauer in Schlauer and Meyers-Rice 1999; however, a taxonomic combination on subspecies rank has never been validly published), or as two distinct species, *D. filiformis* and *D. tracyi* (as put forward by Macfarlane 1914; Shinners 1962; Sorrie 1998; Rice 2010, 2011; Mellichamp 2015; Rice *et al.* 2017; Brittnacher 2018). Special focus in this discussion was put on the allopatry or sympatry of the two taxa: *Drosera tracyi* is a species from the American Gulf Coastal plain, where it is widespread in that region from far western Mississippi (Hancock, Harrison, Jackson, Stone, George, and Perry counties; Rice 2011) and possibly Louisiana (only a single, ambiguous historic herbarium collection lacking parish information is known from that state; Sorrie 1998; Rice 2011) eastward through Southern Alabama (Mobile, Baldwin, Washington, Escambia, and Covington counties) and most of the Florida panhandle (Escambia, Santa Rosa, Okaloosa, Walton, Holmes, Washington, Bay, Jackson, Calhoun, Gulf, Liberty, Franklin, Leon, and Wakulla counties) (Rice 2011) into Southern Georgia, where it has been collected in Colquitt, Brooks, Calhoun, Cook, Grady, Lowndes, Thomas, and Worth Counties, although persisting in only a few of these counties today (Rice 2011). The occurrence of *D. filiformis* was also mentioned in southwestern South Carolina by Wynne (1944); however, no herbarium records from any member of the *D. filiformis* complex are known from this state (Rice 2011), hence this occurrence is treated as erroneous here. In contrast, *D. filiformis* has a discontinuous range along the Atlantic Coast of mid to north Eastern North America: the few known populations in North Carolina (records of which exist from Bladen, Brunswick, Columbus, Duplin, Pender, Robeson, and Sampson counties; Rice 2011) are separated by more than 450 km from the species` main range along the mid-Atlantic coast in New Jersey (Middlesex, Monmouth, Ocean, Burlington, Camden, Atlantic, and Cape May counties; J. Ksepka, pers. comm.), New York (Suffolk County), Massachusetts (Plymouth, Barnstable, Nantucket, and Dukes counties), and, historically, Rhode Island (Washington County) as well as Connecticut (New London and Hartford counties), although

from these states it has apparently been extirpated (Sorrie 1998; Rice 2011). The mid-Atlantic distribution center of *D. filiformis* is followed by another large disjunction of over 450 km to the northernmost metapopulation of this species in Shelburne County, Nova Scotia, Canada (Sorrie 1998; Rice 2011; Schnell 2022; Rice *et al.* 2017). The sole apparent range overlap of both species was reported from a few sites in Bay and Washington counties of northwestern Florida. The discovery of putative *D. filiformis* (var. *filiformis*) in Florida, first reported by Godfrey (1974), was unexpected because these populations occurred more than 850 km south of the species' southernmost known populations in North Carolina and roughly in the center of "*D. tracyi* territory". This apparent range overlap led some botanists to question the presumed allopatry of *D. tracyi* and *D. filiformis*, resulting in renewed support for treating the two recognized taxa as varieties of *D. filiformis* (Schnell 1995, 2002). This changed when the distinctiveness of the Florida populations of *D. filiformis* was recognized (Rice 2010, 2011) and these intensively red-colored, sand-growing plants were subsequently treated as the third accepted thread-leaf sundew taxon, *D. filiformis* var. *floridana* (Rice in Rice *et al.* 2017).

Following comparative studies conducted in the field and with cultivated plants of all accepted North American *Drosera* species, several previously unrecorded characters of *D. filiformis* var. *floridana* were discovered. After several years of thorough field documentation by the first author, new evidence is presented to support the concept of *D. floridana* as a distinctly recognizable taxonomic entity, which is elevated here to the rank of species.

## Materials and methods

A comprehensive sampling of herbarium specimens of *Drosera filiformis*, *D. tracyi*, and *D. floridana* housed at the University of Florida Herbarium (FLAS) was examined under a stereo microscope. Morphometric data utilized in the description of *D. floridana* and the comparative tables were obtained both from herbarium specimens as well as directly from living plants studied in the field by the first author across many sites: between October 2021 and July 2026, *D. tracyi* was studied at more than 100 sites in the Mississippi counties of Stone, Jackson, and Harrison; the Alabama counties of Washington, Baldwin, Escambia, and Conecuh; and the Florida counties of Escambia, Santa Rosa, Okaloosa, Walton, Holmes, Washington, Bay, Jackson, Calhoun, Gulf, Franklin, Liberty, Leon, and Wakulla. Between May 2023 and July 2026, *D. floridana* was studied at 13 sites across the Florida counties of Bay and Washington. During July 2026, *Drosera filiformis* was studied at nine sites in Columbus County, North Carolina, Ocean County, New Jersey, Plymouth County, Massachusetts, and Barnstable County, Massachusetts. Seeds of all thread-leaf sundew species were imaged at 40× magnification under a macroscope (Zeiss, Germany) with a mounted digital camera (Sony, Japan) and stacking photography software (Helicon Focus, Ukraine). The distribution map was prepared with QGIS v4.2 and Photoshop (Adobe.com) based on herbarium records and supplemented with citizen science records obtained from iNaturalist (www.inaturalist.org, last accessed 28 July 2026).

## Results

### Taxonomy

***Drosera floridana*** (B.Rice) Juve & A.Fleischm., **comb. nov. & stat. nov.** (Figs. 1–5)
Basionym: *Drosera filiformis* Raf. var. *floridana* B.Rice, in Rice *et al.*, Drosera World 2: 998 (2017).
Type: United States, Florida, Washington Co., growing on the margins of [exact locality withheld] Lake, 20 m, plants red throughout, 29 May 2010, *Rice BR100504* (holotype: DAV188879 photo!).

Description: Perennial herb, 7–36 cm tall including inflorescence. Roots predominantly adventitious, sparse, simple, terete, blackish brown, slightly fleshy, becoming wiry with age, persistent. Stem short and column-like, erect, self-supporting, occasionally becoming prostrate, after which apical growth will continue decumbently, terete, unbranched, 1–5 cm long, c. 4–6 mm diam.; internodes very short, largely invisible beneath spent leaves and stipules, which typically dehisce not at the base of attachment but 0.5–3 cm along their length, composing a shaggy stalk of old growth. Leaves in an apical, semi-globose rosette, erect at initial development but becoming horizontal with age correlating with an increase in ascension at near distal end, stipulate; stipules lanuginose, 8–15 × 5–7(10) mm, whitish, drying pale brown, adnate to the lowermost ca. 5–7 mm of the adaxial petiole base along their entire length, stipule along its apical and the two lateral margins deeply divided into multitudinous, long, lanuginose setae; setae filiform from very narrowly triangular base, ca. 0.3 mm wide at their base, up to 10 mm long, terete, simple, slightly twisted, translucent white; petiole linear, (2–)3–6(–12) mm long, 0.8–1.2 mm wide near base, gradually narrowing to 0.6–1.0 mm near lamina, very slightly arcuate abaxially (curved outwards), transversely elliptic in cross-section, margins slightly reflexed but never contacting, adaxial and abaxial sides both (rarely) greenish to (often) dark red superficially glabrous but adaxially and abaxially covered with very small, ubiquitous translucent to red microsessile glands; lamina linear, filiform, (rarely) greenish to (often) dark red, 5–10(–22 cm) long, 0.6–1.0 mm wide at proximal end, tapering to ca. 0.1 mm at distal end, slightly to strongly arcuate adaxially (curved inwards), transversely elliptic in cross-section, margins slightly reflexed (becoming the most strongly reflexed at a point a roughly half of the total length of the lamina) but never contacting or forming a distinct channel, abaxial and adaxial surfaces covered with very small, ubiquitous translucent to red microsessile glands and stalked, carnivorous secretory capitate glands (tentacles); tentacle stalks red, uniformly 0.4–0.7 mm long across width of lamina near proximal end, with tentacles becoming increasingly dimorphic towards the leaf apex; marginal tentacles reaching 2.0 mm in length whereas inner lamina tentacles only ca. 0.3 mm long; long, marginal tentacles often becoming strongly reflexed (facing outward); tentacle gland heads radially symmetric, red, ca. 0.1 mm long, gland heads of marginal tentacles slightly longer but lacking a distinct morphological binary dictated by their placement on the leaf; *Inflorescences* 1(–5), each forming a (4–)10–23-flowered, bracteate, one-sided scorpioid cyme; peduncle terete, erect, yellowish green to reddish but turning blackish with age, 8–18(–28) cm long, 0.7–1.4 mm diameter near base, superficially glabrous but uniformly sparsely covered with very small, ubiquitous, translucent to red microsessile glands, reducing slightly to 0.6–1.3 mm wide towards the rachis; rachis 2.9–17.3(–29) cm long, 0.3–1.3 mm diameter; rachis, pedicels, and calyx all with ubiquitous microsessile glands; pedicels terete, superficially glabrous with microsessile glands or rarely covered with few infrequent stalked glands, linear and erect at anthesis, remaining erect in fruit, 1.0–2.6 mm long, 0.1–0.4 mm diameter, spaced by 3.1–9.2(–23.4) mm (reducing towards apex of inflorescence, lowermost pedicels often spaced far

Figure 1. Habitat (top) and habitus (below) of *Drosera floridana*, in Washington County, Florida. Photos by Noah Juve.

more distantly than on the rest of the rhachis); bracts very narrowly oblanceolate 1.0–3.7 mm long, lateral margins entire, apex acute, rarely irregularly crenate, often tapering to a narrow filament, 0.2–0.5 mm wide, adaxial and abaxial surfaces superficially glabrous but with microsessile glands, rarely with few irregular, scattered stalked glands, lowermost pedicels on a scape occasionally lacking bracts, bracts rarely replaced by longer, carnivorous leaves to 6 mm in length with a frequency lowest during the first mass blooming event and increasing with secondary, later-season inflorescences; flowers 13–19 mm in diameter. Sepals 5, ovate to elliptic, basally adnate (forming a flat-campanulate calyx), margins entire with acute apex, 2.1–2.9 mm long, 1.1–1.5 mm at their greatest width, abaxial surface densely covered with stalked capitate trichomes translucent, red, or bicolored to 0.2 mm in length; petals 5, obovate, broadly obovate, truncate or cuneate, apical margin finely crenulate, 6–9 mm long, 4–6 mm wide at their widest point, pink, pale pink, or very rarely white; petal aestivation imbricate, contorted. Stamens 5, alternipetal, ca. 3 mm long, 0.7–1.0 mm wide; filaments straight, narrow, transversely elliptical in cross-section, ca. 2.5 mm long, expanding to ca. 0.2 mm wide at apex, white to pale pink; anthers bithecate, 0.4–1.0 mm long, 0.4–1.2 mm wide, thecae pale yellow, pollen pale yellow; ovary 3-carpellate, fused, subglobose, 0.9–1.4 mm in diameter, glabrous, yellowish green. Styles 3, each basally divided into 2 entire style-arms; style-arms flagelliform, terete, 1.2–1.7 mm long (excluding stigmatic portion), ca. 0.1 mm in diameter, translucent white, glabrous, usually arcuately curved upwards, graduating into stigmatic part; stigmas narrowly cuneate to narrowly club-shaped, often with bifurcate apex, 0.4–0.6 mm long, 0.2–0.6 mm in diameter, translucent white, papillate; seeds numerous, ca. 600–700 µm long, 300–400 µm wide, narrowly ovoid to ellipsoid, testa black with slightly iridescent shine of the periclinal walls, testa surface isodiametrically reticulate.

Etymology: The varietal epithet "floridana" was selected by Barry Rice in his description of this taxon (Rice in Rice *et al*. 2017: 998–1005) in reference to its geographic range, which is limited to the state of Florida. In this revision, it is upheld as a specific epithet fitting for this Florida microendemic sundew.

Distribution: *Drosera floridana* is endemic to a very small geographic area ca. 100–300 m in elevation, spanning southern Washington County, Florida and northern Bay County, Florida. Its known area of occurrence is roughly 25 km × 20 km in size and resides at the central-southern end of the *D. tracyi* range, which extends across at least four states and is roughly 650 km × 140 km. The known distribution of *D. floridana* is flanked by the Econfina Creek to the east and the larger Choctawhatchee River drainage to the west and is located exclusively within the confines of the Greenhead Slope Lake Region (Griffith *et al.* 2026), existing as part of the greater Econfina Karst Region (Means 2011), which also encompasses the westerly Fountain Slope, which has similar karst topography but lacks the numerous lakes with littoral zone white sand seepages present throughout the Greenhead Slope Lake Region. Despite its poor historic study and documentation, the Econfina Karst Region is a known biodiversity hotspot within the state of Florida, with many geographically restricted plant species present (Godfrey 1974; Means 2011). Waterbodies present within the Greenhead Slope Lake Region are recognized among the most acidic and oligotrophic lakes in North America (Griffith *et al.* 2026). Native occurrences of *D. floridana* are unlikely to be discovered outside of the biogeographically very unique Greenhead Slope Lake region. Collections made from Liberty and Jackson Counties, Florida (*Anderson 10436* (FSU) and *Anderson 32738* (FSU)) recorded

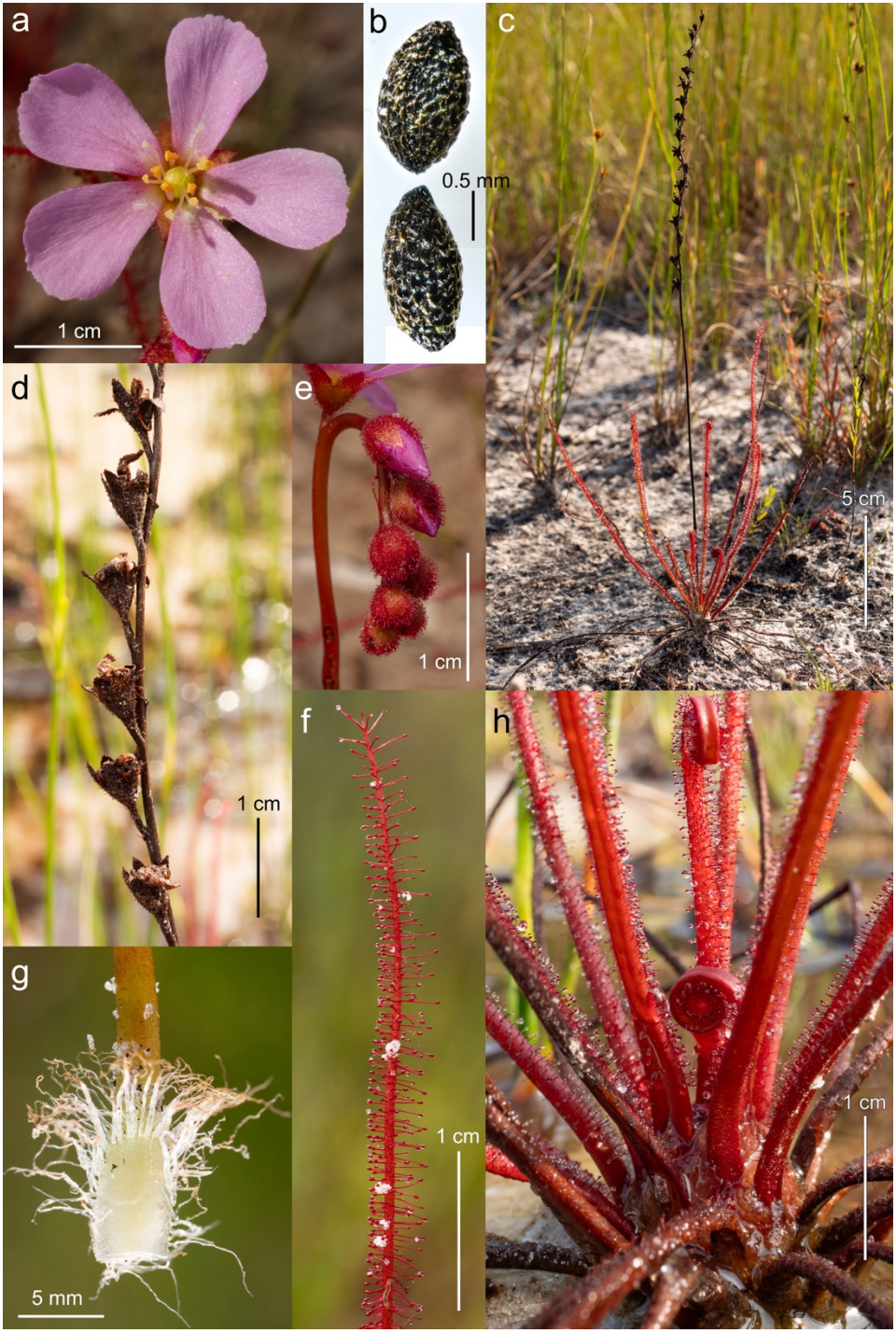
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Figure 2. *Drosera floridana*. (a) flower. (b) seed. (c) habit of a fruiting plant. (d) infructescence. (e) sepals, bracts and indumentum of the developing scape. (f) apical part of a mature leaf. (g) stipule at the petiole base of a detached leaf. (h) plant base and newly emerging leaves. Scale bars indicated, based on in situ photographs taken with a ruler. All photos taken in Washington County, Florida, or of plant material sourced from Washington County, Florida. Photos by Noah Juve.

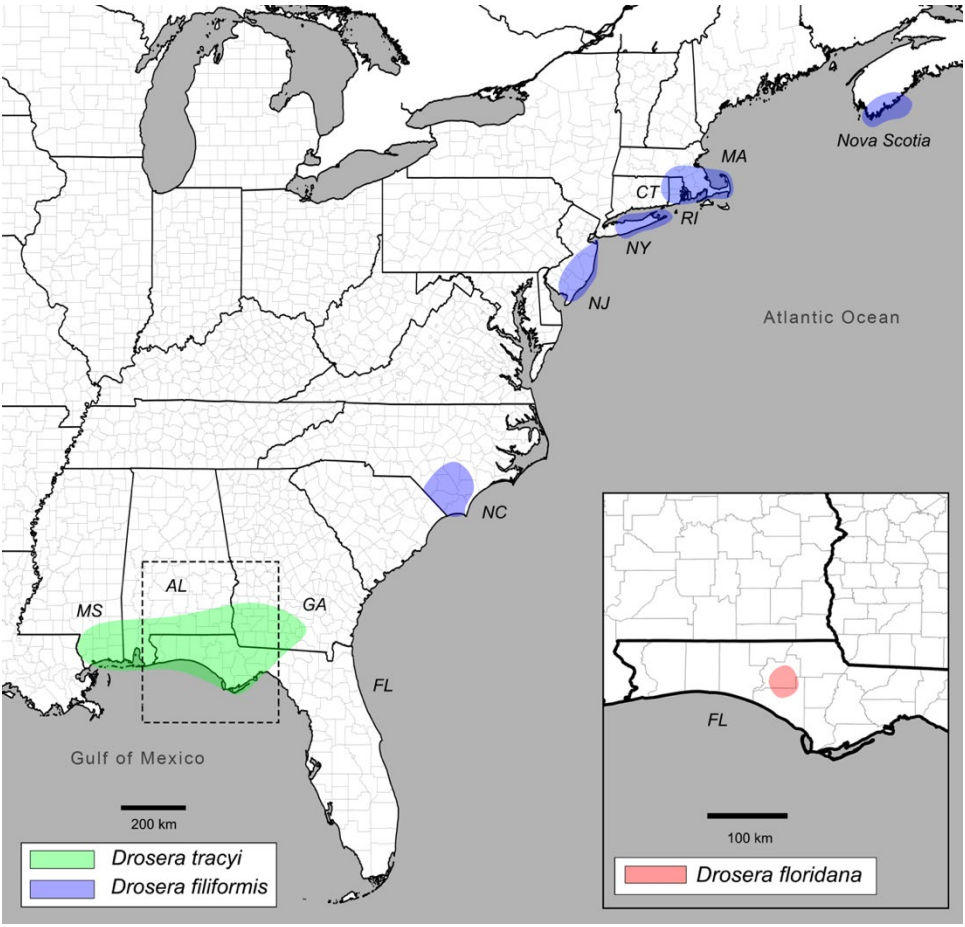


Figure 3. Distribution of the three thread-leaf *Drosera* species. Map prepared by A. Dietrick.

as "*D. filiformis*" have been determined by the authors of the present work to represent reddish-tentacled *D. tracyi*. *Drosera floridana* has been deliberately introduced to at least two sites east of the Apalachicola River drainage in Liberty and Wakulla Counties, Florida, with one site additionally hosting introduced *Dionaea muscipula*. Illegal acts such as this do not aid in the actual conservation of *D. floridana* and disrupt existing local carnivorous plant populations. Lacking the specialized habitat that favors *D. floridana* as the dominant thread-leaf sundew, these introduced populations, if

they persist, are likely to become hybrid swarms with nearby *D. tracyi* in the long run, as is seen in similarly unnatural roadside relic populations within the natural range of *D. floridana*.

Habitat: *Drosera floridana* occupies a distinct ecotone associated with rare littoral seepage areas along the margins of sinkhole lakes whose water surface represents an exposed surficial aquifer (Means 2011) that is intermediate in moisture ephemerality between the preferred habitat zones of the sympatric *D. capillaris* Poir. and *D. tracyi*. Within the range of *D. floridana*, *D. tracyi* occurs only around truly perennial seepages high on lake margins in soils often composed of some significant peat or organic soil content. Typically, *D. tracyi* is encountered only around the sources of littoral zone seeps where darker soils are present and other bog companion plants establish, remaining vegetatively persistent even during periods of drought on account of the reliable water output from the specific exfiltration zones around which it grows. *Drosera tracyi* does not appear to regenerate populations readily from a soil seedbank as is common with other taxa of *Drosera* sect. *Drosera*, including *D. capillaris* and *D. brevifolia* Pursh (Fisher Parrish and Tyler Gramley, pers. comm.). In contrast to *D. tracyi*, *D. capillaris* is a very opportunistic species capable of colonizing lower littoral zone habitats with no association to seepage areas, often occurring around those lakes in the Econfina Karst Region with no seepage zones present and representing the most ecologically generalist sundew of this biogeographic area. In wet years, *D. capillaris* will appear in soils of pure sand on non-seepage lake margin zones, growing to maturity and setting seed in a matter of months. In dry years, however, *D. capillaris* plants will die in these habitats, unable to procure sufficient moisture from the parched sands. *D. capillaris* will persist as a dormant seedbank in the soil until the water level rises following substantial rainfall.

*Drosera floridana* occurs primarily in the vicinity of littoral zone seeps, but is not restricted to only areas of permanent moisture availability. *D. floridana* does not opportunistically colonize lower littoral zones that are unassociated with seepages en masse during temporary periods of moisture availability favorable to *Drosera* growth. *Drosera floridana* prefers white quartz sand substrates and generally occurs in sparsely vegetated seepage margins, often co-occurring only with small Eriocaulaceae, *Xyris* spp., and *Utricularia* spp., but still receiving sufficient moisture from adjacent seepage zones even when no surface water is visible. In years of prolonged or exceptional drought, *D. floridana* populations will typically shrink, with significant numbers of plants on the drier zone of its ecological tolerance perishing, but populations will not vanish altogether; plants nearer to the source of the seeps will persist. Similarly, during exceptionally wet years, at which time the entire littoral zone becomes inundated with water, *D. floridana* populations are likely to suffer significant reductions in size but not total extirpation (higher littoral zone stands survive and lower ones do not), while, again, the low littoral zone populations of *D. capillaris* perish and the high littoral zone populations of *D. tracyi* are largely unaffected. This unique, distinct ecotone created by the routine presence of littoral zone seepages in the Econfina Karst Region—a phenomenon recorded nowhere else within the United States—is likely to have provided selective pressures favoring *D. floridana* as an early-diverging lineage intermediate between small, rosetted sundews and the larger, derived thread-leaved *D. tracyi*, or, conversely, provided a habitat in which an ecologically intermediate alloploid was more successful than both a persistent thread-leaf and small rosetted, ephemeral sundew if *D. floridana* is of reticulated evolutionary origin.

Ecology and phenology: *Drosera floridana* is a perennial plant that blooms between March and November, throughout nearly its entire growing season. Despite co-occurring in the same climatic region (in fact, with a range even extending to some more coastal, southerly habitats that remain warmer throughout the year), the flowering time of *D. tracyi* strictly falls between the months of March and July, with no new inflorescences emerging from the plants under normal environmental conditions beyond the month of May. In contrast, fruiting plants of *D. floridana* often develop a second inflorescence and are capable of repeating this process 3–4 times per growing season, with new inflorescences having been recorded emerging as late as October. Although, like *D. tracyi*, the greatest number of *D. floridana* plants can be observed at peak anthesis in mass flowering events during mid-spring (April), not insignificant numbers of plants within all populations can be observed blooming sporadically throughout the remainder of the growing season. It is more difficult to draw meaningful comparisons between *D. floridana* and *D. filiformis* with regard to phenology on account of significant climatic discrepancies which exist not only between the distributions of *D. floridana* and *D. filiformis*, but within the broad, highly fragmented range of *D. filiformis* itself. The growing season of *D. filiformis*, especially near the northern end of its range, is overall shorter than that of *D. floridana*. At the northern terminus of the *D. filiformis* distribution (Nova Scotia), plants bloom from July to September, while at the southern terminus (North Carolina) anthesis can be observed between May and June. It is not clear to what extent the phenological window of *D. filiformis* is genetically fixed or environmentally influenced, but the very short blooming period experienced within the geographic area of closest equivalency to the American Gulf Coastal Plain (North Carolina) seems to indicate that, like *D. tracyi*, *D. filiformis* only produces one flush of inflorescences between emergence from hibernacula and the next dormancy.

*Drosera floridana* has the shortest and least stringent period of dormancy among the three thread-leaf sundew species, which takes place across only two months (January and February; one sixth of the total year). In February, the reduced, non-carnivorous hibernaculous leaves are quickly replaced by glandular, insect-trapping leaves consecutively increasing in length before full growing season length is achieved between the months of March and April. In contrast, *D. tracyi* does not continue the development of carnivorous leaves into November, and often emerges slightly later from dormancy in February than sympatric *D. floridana*, giving it a dormancy period comprising roughly one quarter of the year. The dormancy period of *D. filiformis* is closest to that of *D. tracyi* at the southern end of its distribution in North Carolina (ca. 4 months during which filiform carnivorous leaves are replaced by a compact, dormant hibernaculum; one third of the year) and lengthiest at the northernmost terminus of its range in Nova Scotia, where it produces no carnivorous leaves and remains dormant for about three quarters of the year (September to May). Again, it is unclear to what degree these phenological discrepancies can be accounted for by climate, but horticultural trials seemingly suggest that *D. filiformis* (especially those from northern populations) are more eager to form hibernacula following short periods of growth than *D. tracyi* and *D. floridana,* even southerly *D. filiformis*. *Drosera floridana* is considered the only North American thread-leaf sundew that can be grown in cultivation with success under constant conditions without any period of dormancy; a notable feature which has long contributed to its desirability among carnivorous plant horticulturalists. Similarly, seedlings of *D. floridana* have been recorded germinating during spring, summer, and fall months, which, combined with horticultural studies, indicates that *D. floridana* seeds lack the germination inhibitors present in *D. filiformis* and *D. tracyi*, whose seeds need a period of cold stratification in order to germinate reliably.

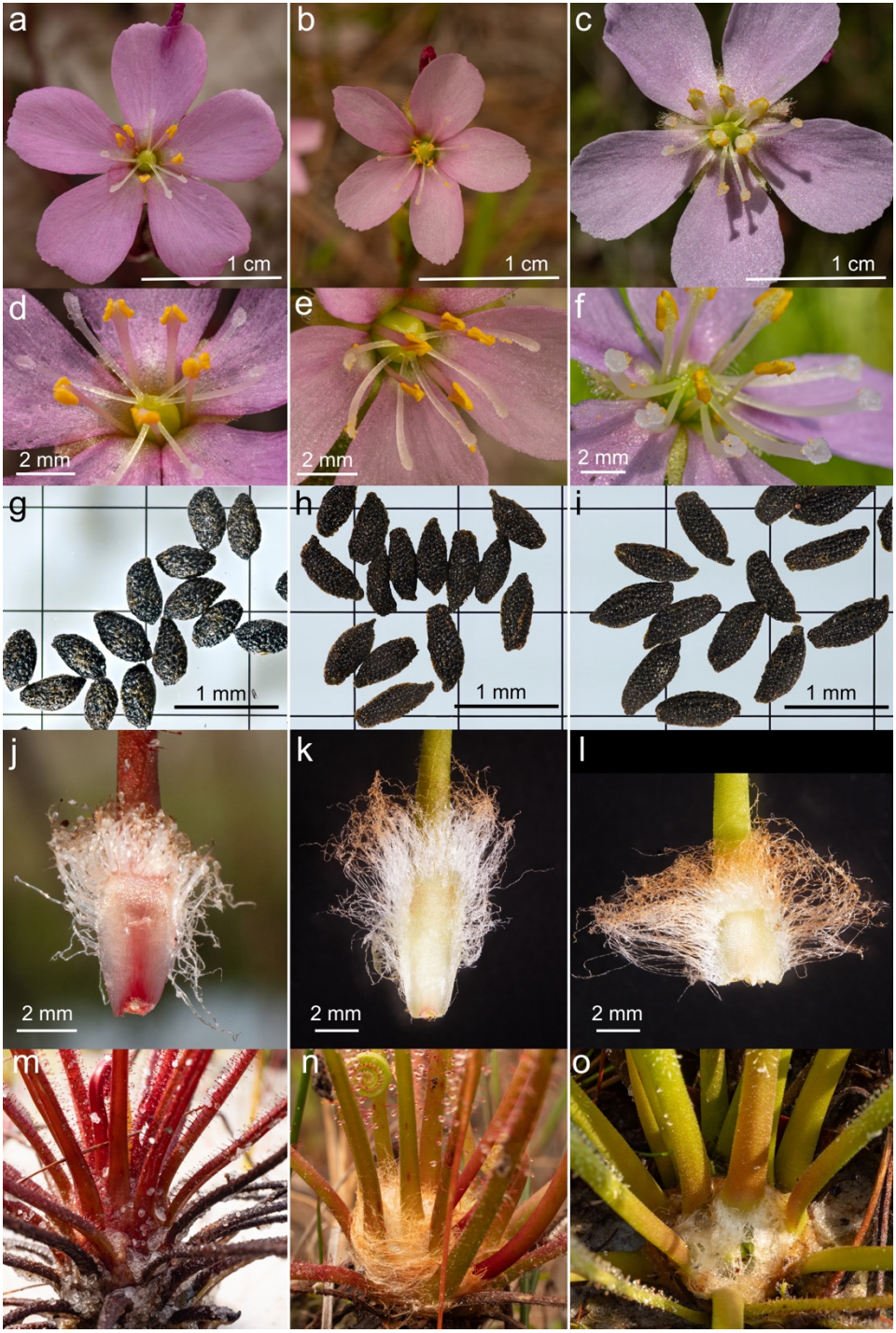
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Figure 4. Comparison of the three thread-leaf sundews: left: *Drosera floridana*. center: *D. filiformis*. right: *D. tracyi*. (a, b, c) flowers in face view. (d, e, f) styles and stigmas. (g, h, i) seed. (j, k, l) stipule. (m, n, o) leaf base. Photos (a, d, g, j, m, o) taken in Washington County, Florida, or of plant material sourced from Washington County, Florida. Photos (b, e, n) taken in Plymouth County, Massachusetts. Photo (c) taken in Santa Rosa County, Florida. Photo (f) taken in Covington County, Alabama. Photos (h, I, k, l) taken from representative horticultural material. Photo (g) by A. Dietrick, (k, l) by A. Fleischmann, all other photos by Noah Juve.

Flower biology: The floral display of *D. floridana* is fundamentally different from that of *D. filiformis* and *D. tracyi*, which is likely connected to a different pollination mechanism. Flowers of *D. filiformis* and *D. tracyi* are notable because they are distinct from the radial symmetry typical of most *Drosera*, exhibiting slight zygomorphy: in both species, the six style arms are not diverging equidistantly and radially across the flower, as typical for other members of *D.* section *Drosera*, including *D. floridana* (the style arms thereby equally spaced from each other by an angle of approximately 60 degrees, see Figs. 4a, d). Instead, in *D. filiformis* and *D. tracyi*, all six style arms are bent more or less horizontally distributed across roughly one semicircle of the flower disc, often spanning an angle of ca. 180 degrees or more between the two outermost style arms (see Figs. 4b, e for *D. filiformis* and 4c, f for *D. tracyi*). This positions all six stigmas in one half of the open flower, while the other half is left without receptive female organs – it is important to note that the six stamens, i.e. the male function of the flower, are maintained radially arranged around the ovary. Hence, zygomorphy is confined to the styles, i.e. the female part of the flower. This goes along with a vertical orientation of the open flower in both *D. filiformis* and *D. tracyi*, i.e. facing sideways (and usually oriented eastwards, facing the morning sun, as first noticed by Wilson 1994), which again is quite unusual for the ephemeral, heliophilous sundew flowers, which in the majority of species are orientated horizontally, i.e. facing sky. Yet, the unusual flower orientation (together with a very early morning anthesis) is connected to buzz pollination and pollen collection by bumblebees and large solitary bees, as demonstrated for *D. tracyi* by Wilson (1994, 1995), but which also likely holds true for *D. filiformis*. This pollination mechanism is favored by vertical floral display, as well as by one-sided style orientation, a pattern also seen in many unrelated, buzz-pollinated plants with similar floral design and often co-occurring with those two *Drosera* species – such as meadow beauty (*Rhexia* spp.; Melastomataceae).

In contrast, the perfectly radially symmetrical flowers of *D. floridana* face the sky and are most likely not consistently buzz-pollinated by larger bees and bumblebees, but are instead often visited by smaller bees and other small generalist pollinators. However, it should be noted that *D. floridana* and sympatric *D. tracyi* are not fully reproductively isolated by different flower design and pollinators. There seems to be at least some pollinator overlap, as it is evident from the occurrence of the natural hybrid *D.* × *arenaria* and its observed occurrences of backcrosses with either parent.

Threats and conservation: *Drosera floridana* is recognized as endangered at the state level in Florida. *Drosera floridana* is threatened primarily by habitat degradation through development, illegal off-road vehicle use on its fragile habitats, and climate change; factors all compounded by its extremely limited distribution and specific ecological preference. This species establishes in association with rare littoral zone seepages, which are often degraded or destroyed by lakeside development. Many lakes around which *D. floridana* has historically occurred have already lost this species (and, often,

p1
p2
2 mm
q1
q2
2 mm
r1
r2
2 mm
s
2 mm
t
2 mm
u
2 mm
v
w
x
y
z
ß

Figure 5. Comparison of the three thread-leaf sundews: left: *Drosera floridana*. center: *D. filiformis*. right: *D. tracyi*. (p1, q1, r1) developing inflorescence, showing bracts and sepal indumentum. (p2, q2, r2) infructescences. (s, t, u) pedicels. (v, w, x), habitus. (y, z, ß) habitat. Photos (p1, p2, s, v, y, r2) taken in Washington County, Florida. Photos (q1, z) taken in Plymouth County, Massachusetts. Photo (q2) taken in Columbus County, North Carolina. Photos (t, w) taken in Ocean County, New Jersey. Photo (r1) taken in Franklin County, Florida. Photos (u, x) taken in Covington County, Alabama. Photo (ß) taken in Liberty County, Florida. Photo (ß) by A. Fleischmann, all other photos by Noah Juve.

the entire littoral zone native plant community as a whole) from their margins, including the lake from which Godfrey made the first recorded herbarium collections of this taxon in 1974, which has since turned into a suburban housing complex. Trash is often discarded directly upon stands of *D. floridana*, off-road vehicles are regularly operated in the open, sandy plains constituting *D. floridana* habitat by local residents as a recreational activity. The driving of these vehicles is effective in degrading the fragile white sand habitats of *D. floridana*. Evidence of such disturbance is consistently observed at most *D. floridana* sites studied by the first author, and, in one instance, has reduced a population of *D. floridana* to only two living plants (July 2026, N. Juve pers. obs.). Altered hydrology, changing rainfall patterns, and increased drought associated with climate change represent additional threats to the continued occurrence of *D. floridana in situ*. The authors consider genetic introgression by hybridization with *D. tracyi* to be an unlikely threat to this taxon; the natural hybrid *D.* × *arenaria* only becomes the dominant thread-leaf sundew taxon in areas of highly altered habitat (namely, routinely mowed roadside ditches) and, at natural sites where *D. tracyi* and *D. floridana* co-occur, is limited to a narrow ecotone of intermediate moisture availability between enclaves of *D. tracyi* and *D. floridana*, lacking the capacity to outcompete either taxon within their respective favored habitat zones. Although most of the lakes potentially suitable (or once suitable) for *D. floridana* are privately owned and therefore have a future that is wholly dictated by the discretion of these private landowning entities (many of which are destined for suburban housing development), a substantial number of lakes hosting extensive *D. floridana* populations are public lands of the Econfina Creek Water Management Area. At these sites, *D. floridana* is not immediately threatened by total habitat loss through housing development, although habitat degradation through illegal off-road activity and climate change are still significant concerns.

## Discussion

*Drosera floridana* clearly belongs to the North American-endemic "thread-leaf sundew" group within *Drosera* section *Drosera* on account of its long, erect leaves with a circinate developmental pattern, conspicuous, stalked glands present on its sepals, and woolly, highly fimbriate stipules that are wholly adnate to the leaf. *Drosera floridana* was initially described as a variety of the allopatric *D. filiformis* by Rice in Rice *et al*. (2017) based on broad similarities in plant habit and superficial ecological parallels. It is clearly distinct from the sympatric *D. tracyi*.

*Drosera filiformis* occurs in three major range segments: Nova Scotia, the US mid-Atlantic, and North Carolina, across which it persists at many localities in a diverse range of habitats, ranging from sandy, non-seepage littoral lake zones, to sphagnum bogs alongside *Sarracenia purpurea* L. (Sorrie 1998; Rice 2011; Rice *et al.* 2017). Formerly, the range of *D. floridana* was considered to represent

a fourth range segment of *D. filiformis* (e.g., Godfrey 1974; Schnell 1995, 2002; Sorrie 1998; Mellichamp 2015), albeit the most highly disjunct and consistently ecologically distinct – forming relatively pure stands only in association with rare karst littoral-zone seepages where it outcompetes *D. tracyi* and intermediate hybrids – although the extent of these dissimilarities was never thoroughly evaluated, even in the formal description of *D. floridana* at variety rank by Rice in Rice *et al*. (2017). This unique ecology complements an unusual combination of morphological characters, which not only distinguish *D. floridana* from both *D. filiformis* and *D. tracyi*, but also cast doubt on earlier assumptions regarding the closest relative of *D. floridana*.

The three species of the *D. filiformis* complex also exhibit slightly different stigma shapes: *D. tracyi* has flabellate to tubate stigmas (Fig. 4f), whereas they are linear to narrowly cuneate in *D. filiformis* (Fig. 4e), and narrowly cuneate to narrowly club-shaped, often with bifurcate apex, in *D. floridana* (Fig. 4d). In terms of stigma shape, *D. floridana* also resembles other temperate and subtropical members of *D.* section *Drosera* (such as *D. capillaris* and *D. intermedia*), and so it does in the horizontal flower orientation and equidistant spacing of the six style arms, while *D. filiformis* and *D. tracyi* show one-sided arrangement of the styles and a vertical orientation of the flowers (see "Flower Biology" above, and Wilson 1994).

The woolly stipules of *D. floridana* are notably different from those of *D. filiformis* and *D. tracyi* upon closer examination. All three species of thread-leaf sundews share deeply fimbriate, woolly stipules which are adnate to the adaxial petiole base along their entire length and on all three of their margins (Figs. 4j–l). The fuzzy appearance of the stipules, which leads to a dense, whitish to pale brown woolly cover of the growth center at the base the rosette, is caused by the stipules being deeply divided to their base into a myriad of lanuginose, filiform setae (Figs. 4j–l; see also Fig. 31L in Diels 1906: 87). However, in *D. floridana*, the individual setae arise from a much wider base, leading to a very narrowly triangular segment that tapers to a long filiform apex (Fig. 4j). This is especially obvious in the setae of the upper stipule margin, i.e. where they are affixed to the petiole base (Fig. 4j). In contrast, the individual setae of both *D. filiformis* and *D. tracyi* are much narrower and entirely filiform throughout their entire length, i.e. they are hair-like from the base (Figs. 4k, l).

The wider stipule segments of *D. floridana* could perhaps indicate a phylogenetic position as an early-diverging sister lineage to *D. filiformis* and *D. tracyi*, with their more narrowly filiform, much more woolly stipule segments being interpreted as the derived state in the thread-leaf sundews. However, it could also indicate a putative (ancient) hybrid (alloploid) origin of *D. floridana*, its ancestors originating from a cross of one of the "more woolly-stipulate" members of thread-leaf sundews with another member of *D.* section *Drosera* with conventional, triangular papery stipules. Hybridogenic species origin is well-documented in *Drosera* (e.g., the amphidiploid species *D. anglica* Huds. and *D. tokaiensis* (Komiya & Shibata) T.Nakamura & Ueda; Wood 1955; Nakano *et al.* 2004), and it should be noted that hybrids and alloploid species of *D.* section *Drosera* commonly develop stipules that are perfectly intermediate in morphology between those of their parents (Macfarlane 1899 – stipules referred to by him as the "basal quadrangular area"; Rosenberg 1909; Nakano *et al*. 2004; Fleischmann 2025). In case *D. floridana* indeed was of alloploid origin, the other evolutionary parent would have had to be another member of *D.* section *Drosera* that contains 7-methyljuglone (ramentaceone), because all three North American thread-leaf sundews only contain ramentaceone as the sole naphthoquinone (including *D. floridana*, see Schlauer *et al.* 2019). Among extant North American sundew species, this would safely exclude *D. brevifolia* and *D. intermedia* Hayne, which contain plumbagin, because hybrid parentage between species with different

naphthoquinone patterns always leads to both regio-isomers being present in the offspring (Schlauer & Fleischmann 2016). Phylogenetic work is ongoing to resolve the evolutionary history of *D. floridana* and its allies (Juve *et al*., in prep.).

*Drosera floridana* is aligned with *D. tracyi* (and excluded from *D. filiformis*) by its endemism within the Gulf Coastal Plain, patent sepals in senescence, a distinctly expanded stigmatic region, a lower petiole:lamina ratio, and greater pedicel spacing and length. *Drosera floridana* is aligned with *D. filiformis* (and excluded from *D. tracyi*) by leaf coloration, leaf margin, tentacle length, plant size, and an affinity for littoral zone habitats. *Drosera filiformis* is aligned with *D. tracyi* (and excluded from *D. floridana*) by seed shape, stipule shape, phenology, and a zygomorphic gynoecium. *Drosera floridana* shares some characters with *D. filiformis* (but not *D. tracyi*), some characters with *D. tracyi* (but not *D. filiformis*), and possesses some that are wholly exclusive to itself within the thread-leaf sundews (Table 1). For these reasons, *D. floridana* is considered by the authors of the present work to be distinct and recognizable at specific rank (as already put forward by Brittnacher 2018). Avian zoochory resulting in gene flow between *D. floridana* and *D. filiformis*, as hypothesized by Barry Rice (in Rice *et al*. 2017) to support the placement of *D. floridana* at varietal rank, is considered unlikely by the authors of the present work. There are few parallels in sympatric flora indicative of significant plant material transport by birds between the Econfina Karst Region of Florida and any of the distinct biogeographic zones hosting metapopulations of *D. filiformis* along the eastern seaboard of the United States, and no existing data or publications to support the idea of avian dispersal between the range of *D. filiformis* and the range of *D. floridana*, exclusively, within the Gulf Coastal Plain. Considering the absence of *D. filiformis* from elsewhere across the Gulf Coastal Plain, and the total absence of *D. floridana* from the eastern seaboard of the North American continent, it is unlikely that more general avian migratory patterns are responsible for a present exchange of genetic information between the geographically isolated Gulf Coast and Atlantic Seaboard thread-leaf sundew taxa.

Taxonomic implications

With the elevation of the hybrid parent *D. filiformis* var. *floridana* to species rank, *D. floridana*, the resulting natural hybrid with *D. tracyi*, *Drosera* × *californica* nothovar. *arenaria* B.Rice must likewise be raised (following rules of ICN, Art. H.5) to the taxonomic rank of species, *Drosera* × *arenaria*, because both parent taxa are at species rank.

***Drosera* × *arenaria*** (B.Rice) Juve & A.Fleischm., **comb. nov. & stat. nov.**

Basionym: *Drosera* × *californica* Cheek nothovar. *arenaria* B.Rice, in Rice *et al.*, Drosera World 2: 1034 (2017).

Type: United States, Florida, Washington Co., [exact locality withheld], 20 m, 29 May 2010, *Rice BR100502* (holotype: DAV188876 photo!).

In all respects, *D.* × *arenaria* is phenotypically, ecologically, and phenologically intermediate between its parent taxa. Because backcrosses with *D. tracyi* and *D. floridana* show little to no apparent reduction in fertility (pers. obs.), *D.* × *arenaria* displays a broad morphological spectrum and can superficially appear as an inconspicuous red-tentacled, late-flowering "*D. tracyi*" on one side of its spectrum, or like an atypically large, robust, orange-colored "*D. floridana*".

Table 1. Morphological comparison of the three North American thread-leaf sundew species (own data, and Sorrie 1998; Rice 2011).

| | *Drosera floridana* | *Drosera filiformis* | *Drosera tracyi* |
|---|---|---|---|
| Sun-grown plant color (appearance in backlight) | Dark red | Orange, pale red or green | Yellowish green to white |
| Leaf length | 5–10(–22) cm | 8–25(–30) cm | 30–55 cm |
| Shape of the stipule setae ("fringes") and width of their base | Very narrowly triangular, base ca. 0.3 mm wide | Filiform from filiform base, less than 0.1 mm wide | Filiform from filiform base, less than 0.1 mm wide |
| Scape length | 8–56 cm | 6–26 cm | 25–60 cm |
| Tentacle color | Dark red | Pale to dark red | Translucent, pink to red pigment confined to tentacle head, very rarely extending to stalk as pink |
| Average tentacle length at leaf midpoint | ca. 2 mm | ca. 2 mm | To ca. 1 mm |
| Margin at leaf midpoint | Lightly reflexed, never contacting or forming a narrow channel on the abaxial surface of the leaf | Strongly reflexed, consistently coming into contact or forming a narrow channel on the abaxial surface of the leaf | Lightly reflexed, never contacting or forming a narrow channel on the abaxial surface of the leaf |
| Petiole length as percentage of total leaf length in mature plants | 4–6% | 15–18% | 8–10% |
| Petal length | 6–9 mm | 7–10(–12) mm | 12–17(–20) mm |
| Orientation of the six style arms | Equidistantly, radially | Usually one-sided | Always one-sided |
| Stigma shape | Narrowly cuneate to narrowly clavate, apex often bifid | Narrowly cuneate to filiform | Flabelliform to tubate |
| Seed shape | Narrowly ovoid to ellipsoid | Narrowly ellipsoid | Narrowly ellipsoid |
| Calyx behavior in fruit | Sepals patent | Sepals clasping | Sepals patent |
| Habitat | Semi-persistent ecotone with white quartz sand on lake littoral zone seepage margins | *Sphagnum* bogs, late-successional sandy woodland seepages, non-seepage high littoral zones of lakes, and bay rims of clay or sand-based pocosins | Fire-dependent peat or sand-based wet wiregrass longleaf pine savannas |

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*Drosera floridana* growing in quartz sand in Washington County, Florida. Photo by Noah Juve.