

CARNIVOROUS PLANT NEWSLETTER

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Front Cover: *Drosera rotundifolia* growing with a juvenile *Nepenthes pulchra* in a tropical montane peat bog in the Philippines. Photo by Fulgent Coritico. Article on page 7.

Back Cover: *Drosera lusitanicum* leaf unfurling. Photo by Barry Rice. Article on page 29.

Carnivorous Plant Newsletter is dedicated to spreading knowledge and news related to carnivorous plants. Reader contributions are essential for this mission to be successful. Do not hesitate to contact the editors with information about your plants, conservation projects, field trips, or noteworthy events. Advertisers should contact the editors. Views expressed in this publication are those of the authors, not the editorial staff.

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ANNOUNCEMENTS

13TH ICPS CONFERENCE - JAPAN: POSTPONED UNTIL 2022

The 13th ICPS Conference in Himeji, Japan, has been postponed until May 2022 because of the COVID-19 pandemic. The ICPS is working with the conference hosts to determine the exact dates and logistical issues and we will communicate this as soon as practicable. We thank the conference organizing team for their patience and persistence to ensure this event will be a success.

WORLD CARNIVOROUS PLANT DAY

World Carnivorous Plant Day was first brought to the attention of the ICPS Board of Directors in 2020 by Krzysztof Banaś of Poland. Krzysztof envisioned a day that brought carnivorous plants into the spotlight of public awareness and education.

The ICPS is proud to promote this day which will be the first Wednesday of May (May 5, 2021). Why, you might ask, select a day in the first week of May? Although numerous important events relevant to carnivorous plants occurred during the first week of May, perhaps the earliest is the first edition of Linnaeus' "Species Plantarum" (the starting point of plant nomenclature, and thus the first date on which carnivorous plants have been described with validly published names) was published on May 1, 1753.

To feature these wonderful plants, the ICPS will be hosting a number of online events. These include a photo contest and a FREE web-based conference featuring a global selection of botanists, horticulturalists, and other enthusiasts invited to share their knowledge of and experiences with carnivorous plants from all over the world in a universally accessible way.

World Carnivorous Plant Day 2021 will serve as the preeminent event of the year regarding carnivorous plants. If you are interested in participating as a contributing speaker for World Carnivorous Plant Day, please contact Carson Trexler at carson@carnivorousplants.org.

ICPS LIFETIME ACHIEVEMENT AWARD, HALL OF FAME, & WALL OF HONOR

RICHARD NUNN • ICPS President • richardnunn@carnivorousplants.org

The ICPS has previously awarded three Lifetime Achievement Awards:

- Adrian Slack 2000
- Sir David Attenborough 2016
- Peter D'Amato 2018

And this year, Dr. Larry Mellichamp has been awarded the ICPS Lifetime Achievement Award.

The ICPS has established criteria for the Lifetime Achievement Award and two additional awards recognizing the efforts of individuals in the field of carnivorous plants or in the service of the ICPS. In establishing these awards, the ICPS wishes not only to recognize the efforts of the individuals, but also to draw attention to research and cultivation of carnivorous plants. The awards are also meant to encourage researchers and growers, especially the next generation of students and hobbyists. Each year, the ICPS will request nominations for these awards.

Lifetime Achievement Award

The Lifetime Achievement Award is presented in recognition of an individual's outstanding leadership and contribution to the field of carnivorous plants. This may be achieved in research, cultivation, conservation, or other ways deemed to be above and beyond the everyday with a significant impact on the field. This award consists of a commemorative work of art presented to the recipient, an article in CPN, and a special page on the ICPS website.

Hall of Fame and Remembrance

The Hall of Fame aims to recognize individuals that would have qualified for the Lifetime Achievement Award but are deceased. A formal certificate stating the induction of the individual will be sent to an appropriate organization that conserves the working life of the inducted individual if appropriate (e.g. Down House in the case of Charles Darwin). There will also be an article in CPN and a special page on the ICPS website.

Wall of Honor

The Wall of Honor is a recognition of long-term service given to the ICPS by individuals. These awards consist of a certificate, placement of a photo with a listing of the provided service on a special page on the ICPS website, and a lifetime membership in the ICPS.

The full criteria and policy for these awards is posted on the ICPS website.
<https://www.carnivorousplants.org/about/Awards/AwardCriteria>

THE ICPS PRESENTS
THE ICPS LIFETIME ACHIEVEMENT AWARD TO
DR. LARRY MELLICHAMP

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The ICPS is honored to congratulate Dr. Larry Mellichamp with its Lifetime Achievement Award, in gratitude for his outstanding and continuous contributions and achievements to carnivorous plants and Sarraceniology, and for his influential, unceasing, and sincere efforts to bring his passion for CPs and all rare plants to others over the span of his long and admirable career.

Dr. Mellichamp is a University of North Carolina at Charlotte Professor Emeritus of Botany and Horticulture and former director of its Botanical Gardens. He has been a core member of ICPS since the early 1970s and CPN editor from 1977-1987. He has been engrossed in *Sarracenia* since the 1960s and is renowned as a leading authority on that genus in both botany and horticulture for over 50 years. Larry, retired from UNCC in 2014 and resides in Charlotte with his wife, Dr. Audrey Mellichamp, also a botanist.

The award was suggested to the ICPS Board of Directors in summer 2020 by Paula Gross, a close colleague of Larry's and fellow horticulturalist and botanist at UNC Charlotte. The physical award itself is a piece of custom botanical art by François Mey of France: a painting of the exquisitely beautiful and extremely rare naturally-occurring *Sarracenia* hybrid, *S. charlesmoorei*, which is the cross of *S. purpurea* subsp. *purpurea* and *S. jonesii* described by Larry in the 2008 CPN (https://cpn.carnivorousplants.org/articles/CPNv37n4p112_117.pdf).



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Larry, the ICPS, & the CPN

Larry actually met with Donald Schnell well before the first CPN issue, just as ideas for what would become the newsletter were being realized. "Count me in!", he told Schnell in his office in Virginia, after Schnell mentioned to him that some sort of club or periodical was soon to be designed specifically for CPs. Having studied *Sarracenia* for a number of years, he necessarily knew Don Schnell and the two had corresponded for some time. Larry would not officially become part of the new organization until somewhat after its inception, but he was indeed part of the early network that developed ICPS. After becoming a CPN editor in 1977, Larry would publish several bite-size botanical histories of most of the known carnivorous plant genera at the time, as well as a collection of other smaller pieces for the early newsletter.

Larry's botanical horticulture

Larry's balanced background of botany and horticulture has served him well as an author of numerous pieces of popular literature and as a teacher of botany, as well as in his cross-disciplinary

projects between those two close yet socially disjointed fields. He has served on the boards of over 20 world-renowned botanical and horticultural societies, many focused on native plants, their cultivation, and their conservation. His direction of the UNCC Botanic Gardens saw their maintenance and further development as a world-class botanical institution, even persevering through decades what would have seen their atrophy under lesser management. His work extended well beyond curation, involving much personally solicited and secured support dependent on decades of reputability, during a time of a mounting lack of support for botanical study in a new industrial age of science, less friendly to the naturalist academics of earlier decades.

Larry's passion: Rare southern flora

Indeed, Larry is one of the relatively few botanists who originate in the American South and study its flora. He notes a depressing dearth in active botanists in the region today, corresponding to a lack of support for botanical study in general. Larry became a hugely influential voice for the biodiversity of the American Southeast through his many publications and influential societal memberships and positions. His interests are hallmarked by a fascination with the rare and the origins of the rare. His necessarily passionate advocacy for broader recognition of the ancient origins and current plight of rare flora of the American South, including its orchids and *Sarracenia*, is a central aspect of his career around which much can be understood. Had he not become a botanist, I imagine Larry would easily have been a world-class historian. His methods seem to lie in understanding the origins of things, a fixation on the rare, the “archaeological” – relics like *S. oreophila* and *S. jonesii* that he refers to as reverently as a historian might to the Egyptian Pyramids. He does this so that we can better understand why things are the way they are. It is in Larry's *interpretation* of botany that becomes both art and illustration in one comprehensive expression.

Larry and the future of Sarraceniology

Larry's work in Sarraceniology is unique among scholars. He has studied them for over 50 years, since he was an undergrad at UNC Charlotte. His early study of *Sarracenia* is at the tail-end of the long era of discovery when scholars finally had described much of what was contemporarily accessible to them and could then look back on things (“Sarraceniology”, a term of his recent invention, is tellingly retrospective in origin). Larry especially among others in the field understands a historiography of the study. One could imagine that such a solid historiography of Sarraceniology might orient the work of future enthusiasts on a bedrock of comprehensive observation and study, fortunately stemming from before the precipitous fall of the genus into its current state of rarity and endangerment. It is critical that our instruments of interpretation are enriched by our predecessors just as they criticize and revise the field that was left to them. Larry witnessed the living range of *Sarracenia* in their prime and was contemporary to other scholars like Fred Case and Donald Schnell. It was in the late 1980s, he notes, that sites began to disappear. The habitat and range of *Sarracenia* began to shrink in the familiar story of habitat degradation. He may as well have witnessed the fall of the Roman Empire. Few others can accurately capture that knowledge in a way meaningful to everybody, and there are none who can transmit it with such authority.

ON TROPICAL *DROSERA ROTUNDIFOLIA* L.

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Abstract: Two aspects on the morphology and biology of the Philippine population of *D. rotundifolia* were not answered by Coritico and Fleischmann (2016), namely its seed morphology and seasonal growth cycle - especially regarding hibernaculum formation, as it is known from its temperate congeners. These gaps can now be covered from observations made from cultivated plants and shall be reported here. Further aspects on the biology of Philippine *D. rotundifolia* (and other tropical populations of temperate *Drosera*) in cultivation and natural habitat are presented.

Distribution and altitudinal range of *Drosera rotundifolia*

The generic type species of *Drosera*, *Drosera rotundifolia* L., is probably the most well-known sundew species, at least to people from the Northern Hemisphere. It is also the most widespread¹, its range spans the entire boreal region (Fig. 1; Meusel *et al.* 1965). Its southernmost populations in the Northern Hemisphere are situated in SE China, in the mountain ranges of northern Guangdong province, at ca. 24.5°N (Coritico & Fleischmann 2016). In Europe its more or less continuous range reaches to ca. 39°N to the south in central Spain, in North America to ca. 34°N in northern Georgia and Alabama states, in Japan to 30°N on the island of Yakushima (Coritico & Fleischmann 2016). Additionally, *D. rotundifolia* shows a few isolated outlier populations in some areas of the Mediterranean [e.g. on the isle of Corsica, France (Delange & Hugot 2020), in the Sierra Nevada of southern Spain (Lorite 2016), and in northern Greece (just three sites known in the Rhodope Mountains; Theodoropoulos & Eleftheriadou 2012)], in central Lebanon (Diels 1906; Tohmé & Tohmé 2007; despite erroneous claims, e.g. by Walker 2015 or Baranyai & Joosten 2016, the species is absent from Israel, misplaced records from “Israel” actually refer to the Lebanese populations), the western Caucasus (W Georgia; Fischer *et al.* 2018, and NE Turkey; Eminağaoğlu *et al.* 2008), in Colorado, USA (only four sites known in the Rocky Mountains; Rice 2019), as well in tropical latitudes on a single high



Figure 1: Global range of *Drosera rotundifolia* L. (based on herbarium records, Meusel *et al.* 1965, Hultén 1971, Schnell 2002, and Coritico & Fleischmann 2016).

¹ *Drosera rotundifolia* has the largest global range, i.e. area of occupancy, of all *Drosera* species. Although *D. intermedia* covers a wider latitudinal range, that species has much smaller areal range.

mountain summit of Mindanao island in the Philippines, and – as single occurrence across the equator – in Papua New Guinea (Coritico & Fleischmann 2016; Fig. 1). Additionally, *D. rotundifolia* has been recently introduced (most likely accidentally by hikers) to the New World Southern Hemisphere in a Patagonian peatbog in Argentina (Vidal-Russell *et al.* 2019). Baranyai & Joosten (2016) erroneously record the species for Cyprus (without further proof), as well as for southern parts of Texas, Mississippi, Alabama, Georgia, and northern Florida, where *D. rotundifolia* is absent and records are based on misidentified *D. capillaris* (Rice *et al.* 2017), or apparently even *D. brevifolia*.

In the Holarctic region, *D. rotundifolia* occurs from sea level in arctic, subarctic and northern coastal regions to up to 2000 m elevation in the European Alps (e.g., Wallnöfer & Vitek 1999; a single outstanding locality at 2484 m: Lunghinsee, Switzerland; Maurizio 2009) and 2100 m in Spain (Paiva 1997), 1800 m at the Caucasian Black Sea coast (Eminağaoğlu *et al.* 2008), reaching 1500 m in mainland Asia (in China; Lu & Kondo 2001), 2000 m in Japan (Diels 1906), and ca. 3000 m at high elevation peatbogs in Colorado, USA (Wolf *et al.* 2006). In the Southeast Asian tropics, it occurs at 1880 m on Mount Limbawon in the Philippines and at 1750 m at Paniai Lakes, Papua, Western New Guinea, Indonesia (Van Steenis 1955; Coritico & Fleischmann 2016; C. Lee, pers. com. 2020).

Habitat of tropical *D. rotundifolia* and tropical populations of temperate species

I am frequently asked by carnivorous plant enthusiasts if the Papuan (and after its discovery also the Philippine) plants were indeed *D. rotundifolia*, or not a different but lookalike species. Although it might sound strange that a temperate bog species occurs on tropical mountain summits, this phenomenon is actually not uncommon in plants – other typical species of boreal flora are likewise commonly found on exposed high mountain summits above tropical rainforest, in Southeast Asia (see Van Steenis 1962, and Coritico & Fleischmann 2016 for examples and explanations) as well as in tropical Africa, often of geologically young arrival (e.g., Assefa *et al.* 2007). Most likely, they reached these habitats by exceptional long-distance dispersal events by chance, and were able to survive and establish persistent populations in these cold tropical highland conditions, although not exposed to a seasonal climate anymore. Interestingly, *Drosera rotundifolia* is not the only temperate carnivorous plant species that reached the highlands of New Guinea, as *Utricularia minor* also has its single Southern Hemisphere occurrence there (Taylor 1977; Coritico & Fleischmann 2016). That the Philippine and Papuan populations of that temperate *Drosera* species were accidentally or intentionally introduced (e.g. by hikers) can arguably be excluded, as both localities are quite remote and have not been visited by anyone except locals previous to the species' initial discoveries (Van Steenis 1955; Coritico & Fleischmann 2016).

In the Philippines, *D. rotundifolia* is known only from a single, small high-altitude peat bog at Mt. Limbawon of the Pantaron mountain range in Bukidnon Province, Mindanao island. The plants occupy a single site, in an open area of just about 100 square meters, in a very wet montane *Sphagnum* bog surrounded by – and slowly overgrown by – dwarf mossy forest (Coritico & Fleischmann 2016; D. Marwinski, pers. com. 2017). In contrast to its preferred sites in temperate regions, the Philippine plants grow in soaking wet peat moss, often partially submerged in seeping water (Fig. 2), accompanied by *Xyris* sp. (yellow-eyed grass; Xyridaceae) and juvenile plants of *Nepenthes ceciliae* and *N. pulchra* (Coritico & Fleischmann 2016; Robinson *et al.* 2017; D. Marwinski, pers. com. 2017). In the New Guinean highlands, *D. rotundifolia* grows in similar conditions at a single high-elevation *Sphagnum* bog in the Paniai Lakes region (Fig. 3; Coritico & Fleischmann 2016; C. Lee, pers. coms. 2007, 2020), accompanied by *Xyris* sp., clubmosses (Lycopodiaceae), bushes of



Figure 2: A tropical highland population of *D. rotundifolia* growing in a very wet montane *Sphagnum* bog on Mindanao, Philippines at 1880 m elevation, accompanied by *Xyris* sp. Photo: David Marwinski.

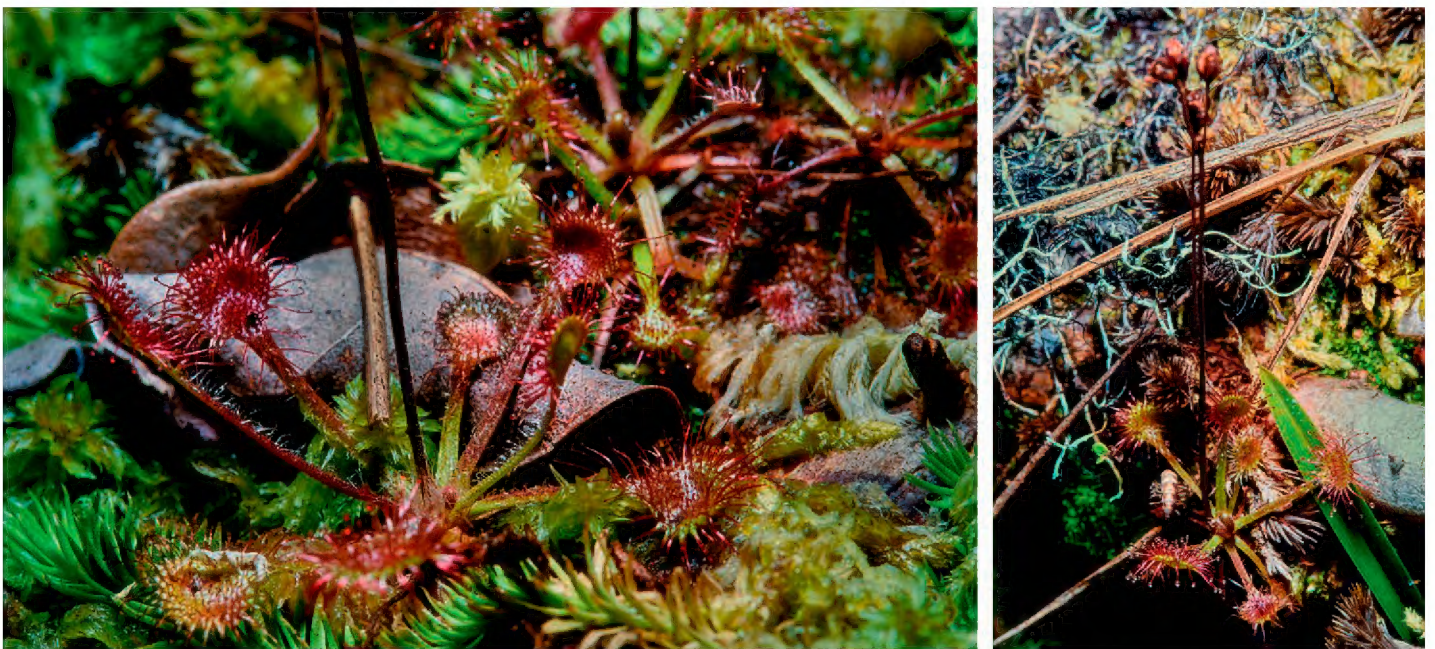


Figure 3: *Drosera rotundifolia* in a high-elevation peat bog in Papua (Irian Jaya), New Guinea, associated with *Sphagnum* sp. and *Lycopodiella* sp. Photos: Chien Lee.

Rhododendron spp. (Ericaceae), *Papuacedrus papuana* (Cupressaceae), *Utricularia* spp. and *Nepenthes maxima* (Fig. 4; C. Lee, pers. obs. 2004, 2006).

In general, the tropical Philippine and Papuan specimens of *D. rotundifolia* tend to have narrower (and a bit more roundish) laminas compared to their European and North American congeners (Fig. 5), which usually have leaf blades that are more transversely broadly elliptic in shape. However, the



Figure 4: Habitat of *Drosera rotundifolia* at Paniai Lakes, Papua New Guinea: a *Sphagnum* swamp among montane dwarf forest. Plants of *Nepenthes maxima* can be spotted growing through the *Rhododendron* scrub on the left. The tallest darker bushes in the background (still not much more than 1 m) are *Papuacedrus papuana*. The *Drosera* grows in the surrounding wet *Sphagnum* carpets with sedges and *Xyris* sp. (yellow flowers bottom right). Photo: Chien Lee.

observed variation in lamina shape in boreal *D. rotundifolia* populations is large, and the two known tropical populations on the Philippines and Papua New Guinea easily fall within that morphological range (Coritico & Fleischmann 2016). In summary, the morphology of the tropical populations of *D. rotundifolia* does not justify separate taxonomic distinction (as suggested by Van Steenis 1955; see Coritico & Fleischmann 2016, who synonymized *D. rotundifolia* var. *bracteata* Steen. with the nominal taxon). The leaf color pattern of the Philippine *D. rotundifolia* in cultivation looks different from wild populations at first sight (having in mind the bright red plants we know from temperate bogs), as the lamina of the active leaves remains bright yellowish-green even if exposed to bright light levels (only the petiole is vividly wine-red), starting to turn red from its middle only in aged, senescent leaves (Fig. 5C,D). However, that color pattern is identical to that observed in wild populations of tropical high-elevation bogs in the Philippines (Fig. 2) and in Papua New Guinea (Fig. 3). Actually, it is also the same in most Northern Hemisphere populations of *D. rotundifolia* if we have a closer look, as the newly developed and active leaves of that species always have a green lamina lined with bright red tentacles – only aged leaves of that species are turning fully red.

Flowers and breeding

Philippine *D. rotundifolia* have white anther thecae and pollen (Fig. 5E) like most of their North American and Asian congeners, while European populations frequently show pale yellow pollen. In



Figure 5: Cultivated *D. rotundifolia* of Philippine origin. A, B. first year of growth from seed. C. forming ca. 2 cm tall columns after 3.5 years of perennial growth. D. close-up of the leaves. E. flower at early anthesis, pollen sacs just beginning to split open. F. seed pods. Images not to scale. Photos: Andreas Fleischmann.

all other respects, the flowers are, however, identical. Exactly like in temperate *D. rotundifolia*, each individual flower of the Philippine plants will open only for a few hours in the late morning on a single day, and only under bright sunny conditions. Under high humidity in a closed terrarium, the petals will not spread open and the flowers self-pollinate cleistogamously. Under the author's growing conditions, seed set of the open, chasmogamous flowers was better, although the cleistogamous flowers also set viable seed (yet in lower number and with larger portion of aborted, sterile grains). In this respect, the facultatively cleistogamous species *D. rotundifolia* is perfectly pre-adapted for growing on a cool, foggy and rainy high montane tropical summit. Artificial cross-pollination with *D. rotundifolia* from German provenance produced viable seeds (reciprocal on both seed parents; anthers were removed before the thecae split open in order to avoid self-pollination). The resulting offspring generation is growing well (under tropical highland conditions), the plants have not flowered so far thus nothing can be said about fertility yet. A manmade cross with *D. anglica* from Hawai'i produced seed which germinated as well – hence “tropical *D. × obovata*” can theoretically be created – at least artificially, as both hybrid parents are naturally separated by ca. 8,600 km [5,400 mi] of Pacific Ocean.

Seeds and dispersal

Drosera rotundifolia seeds are perfectly adapted to wind-dispersal by their fusiform shape and extremely thin seed coat (the testa in this species is so thin that the dormant embryo inside shows

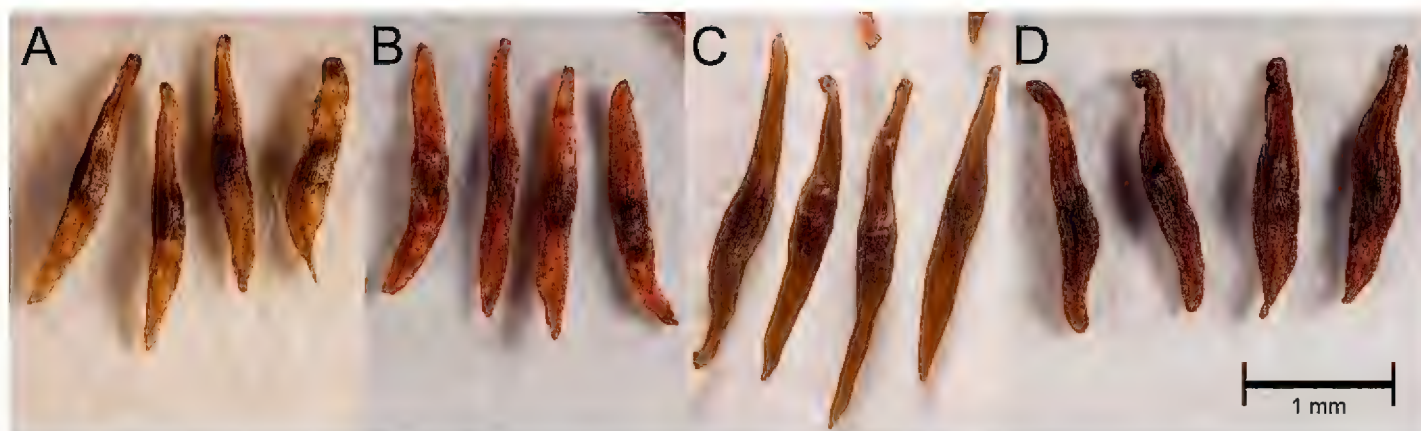


Figure 6: Comparison of *D. rotundifolia* seeds from different geographical origin. A. Chippewa County, Michigan, USA. B. Bavaria, Germany. C. Yakushima, Japan. D. Mindanao, Philippines. Fresh seeds, all at the same scale. Photos: Andreas Fleischmann.

through as dark elliptic structure in the center; Fig. 6) – in this respect, *D. rotundifolia* differs from all remaining *Drosera* species, which have much thicker, non-translucent seed coats. Only seeds of *D. communis* and *D. grantsau* are similar to those of *D. rotundifolia* in this respect – three species with lightweight, short-lived seeds, comparable to those of orchids. Philippine *D. rotundifolia* have a slightly thicker testa and relatively shorter fusiform appendages (Fig. 6) compared to their more northern congeners – nevertheless it is the same species, but maybe just an adaptation to an isolated summit on an oceanic island. A small excursion on seed shape and wind dispersal on oceanic islands:

In oceanic island populations of plants, a secondary reduction or full loss of seed appendages or outgrowths that are normally used in anemochorous (wind-dispersed) plants for surface extension to increase lift for wind dispersal is frequently observed, often in quite short-term, i.e. in just a few generations time (Carlquist 1966; Cody & Overton 1996). This phenomenon is interpreted as an adapted local dispersal strategy on wind-swept islands to avoid propagules being drifted away to the sea and drown (Cody & Overton 1996; García-Verdugo *et al.* 2017), and interestingly it is paralleled in several lineages of winged insects which secondarily became flightless (so-called brachyptery or aptery, i.e. strongly reduced wings or fully wingless individuals) on oceanic islands for the very same reason (Roff 1990). Wide dispersal ability leads to greater seed loss on oceanic islands, hence in many cases special “oceanic island morphologies” that limit dispersal are selected by evolution (Cody & Overton 1996). Or, the other way round, seed morphologies with more limited dispersal ability are retained there because they are not negatively selected against, as wide dispersal is of no use on oceanic islands (Carlquist 1966). The roundish, unusual seeds of the Seychelles islands endemic *Nepenthes pervillei* might come to mind here, which lack the characteristic fusiform shape and the filamentous appendages on both sides that are characteristic for the seed of all other *Nepenthes* species. Indeed, these unusual seeds can be taken as an example for adaptation to oceanic island conditions, however with *N. pervillei* being sister to all remaining *Nepenthes* species, this seed shape might as well represent the ancestral condition in the genus. The case of *D. rotundifolia* is different of course, as here this character is only found in a certain population of a given species in adaptation to oceanic island conditions; moreover, *D. rotundifolia* belongs to a more derived group of sundews.

Thus, many plants with wind-dispersed seed reach remote oceanic islands by wind-driven long-distance dispersal (perhaps also mediated by migratory birds). Yet, once arrived and established there, island populations often evolve away from dispersal by wind in order to stay where they are (the so-called “loss of dispersal ability hypothesis”; García-Verdugo *et al.* 2017; but see Burns

2018 for counter-arguments). Such a case might have happened in the Philippine population of *D. rotundifolia* – a species with seeds normally very well-adapted to wind dispersal, being one of the *Drosera* species with the thinnest seed coat and longest filamentous testa appendages of its fusiform seeds. The Philippine population of that species in contrast has seeds with much thicker testa (as evident already by the darker brown color; Fig. 6) and slightly shorter appendages on both poles. In contrast, seed of the Hawai’ian populations of *D. anglica* does not differ notably from that of its mainland congeners – but that species seems to have a generally more reduced wind dispersal potential based on seed morphology. Seeds of *D. rotundifolia* from Yakushima island, Japan, do not show reduced seed appendages or thicker testa, in fact they are even slightly longer (Fig. 6), however that population occurs in a valley, not exposed on a wind-swept summit like the Philippine plants on Mt. Limbawon.

Cultivation and dormancy

Seed-grown plants of Philippine origin were kept under artificial lights in a terrarium under tropical conditions (photoperiod of 12 hours), with day temperatures between ca. 15-25°C (59-77°F) and night temperatures of ca. 5-15°C (41-59°F) year-round (cooler room temperatures in winter, higher ones in summer). Under these conditions, the plants are growing continuously without forming any hibernacula for nearly four years now, flowering mainly during the cooler months. After anthesis and fruit set, the plants slow down growth, sometimes not producing new leaves for several weeks, but without formation of any resting organs (see also Snyder 2006 for an artificially created, perennially growing cultivar of *D. rotundifolia*). In contrast, plants of Philippine *D. rotundifolia* that were kept under natural light conditions started forming hibernacula by mid-autumn (the same growth pattern holds true for tropical *D. anglica* from Hawai’i and tropical *D. intermedia* from Venezuela and Brazil²), no matter if kept in the heated hothouse, in the coolhouse, or outdoors. Hence it seems obvious that the hibernacula formation in these temperate *Drosera* species is induced by a decrease in daylength, but not by temperature. Plants kept indoors in a terrarium under 12 hr photoperiod never formed hibernacula, even when exposed to colder temperatures for prolonged time. Plants of Philippine *D. rotundifolia* that were kept outdoors in the summer 2018 also formed winter buds in autumn, but did not survive a cold dormancy during winter. Interestingly, plants of *D. rotundifolia* from subtropical climates, e.g. Yakushima island, Japan (at 30°N, Köppen climate classification *Cfa*), or Kagoshima, Japan (ca. 31°N, *Cfa*), or more southern US localities, if exposed to stable (tropical) light and temperature conditions in cultivation, will still form winter buds after some time of sustained perennial growth, and then eventually die arrested as winter bud (pers. obs., M. Hochberg, pers. com. 2007; Kagawa 2015 reports that some subtropical populations of *D. rotundifolia* in Japan that are exposed to hot summer temperatures in their habitats can grow as annuals). Hence a seasonal cold dormancy seems to be essential for the annual growth cycle and healthy growth of that temperate species. The Philippine tropical strain, in contrast, seems to be persistent under tropical cool highland conditions, never demanding for a dormancy.

Acknowledgements: Fernando Rivadavia, Seiji Hirano and Klaus Keller are thanked for providing seeds of *D. rotundifolia* from the USA and Japan, Fulgent Coritico and David Marwinski for report-

² The fact that the three temperate species that have outlying populations in tropical or subtropical regions all still show the ability to form winter buds indicates a) their evolutionary origin in the temperate (boreal) Northern Hemisphere and b) that their individual long-distance dispersals to the tropics have happened quite recently (see also Coritico & Fleischmann 2016; Fleischmann *et al.* 2018).

ing observations and sharing photographs of *D. rotundifolia* from Mindanao, Philippines, and Chien Lee for information and photographs of the species and its habitat from Papua New Guinea. Barry Rice and Jan Schlauer are thanked for helpful comments on the manuscript.

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POLLINATION OF *DIONAEA MUSCIPULA*, THE VENUS FLYTRAP

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Abstract: *Dionaea* flowers are pollinated by insects, primarily bees, in both their native habitat in the Carolinas and in the population growing from seed scattered many years ago in the Florida panhandle, the location of this study. The green sweat bee (*Augochlorella* sp.) is a major pollinator in both habitats, while various flower visiting beetles play a prominent role in the Carolinas and bumblebees (*Bombus* sp.) play a major role in the Florida population.

Flowers open in late morning and pollen is on anthers arrayed directly above the center of the flower by 11:30 EST. Twenty-four hours later the stamens have bent so that the anthers are at the periphery of the flower and the stigma has expanded, presenting a papillate surface receptive to pollen. Insects visit the flower between 11:30 EST and 18:00 EST.

Rewards for pollinators are pollen and nectar from glands at the base of the petals. Possible attractants include the bright white radially symmetrical corolla with radiating grey veins, and on the second day, the radially displayed stamens that may act as a “nectar guide”. No markings on the petals are visible in the ultraviolet light but the pollen-laden anthers are UV-fluorescent and would stand out as a ring of dots to any UV-perceptive insect.

Introduction

There have been two notable contributions to the pollination ecology of *Dionaea muscipula*, both made in its native habitat in the Carolinas. The first, by Roberts and Oosting (1958), established the dates of flowering, its induction by photoperiod, and the development of flowers, as well as proposing possible pollinators based on observed floral visitors. The second by Youngsteadt *et al.* (2018) is a thorough quantitative examination of the visitors and pollinators of *Dionaea* finding the most common pollinators to be two species of small solitary bees and several species of beetles that specialize in pollination. The primary objective of Youngsteadt *et al.* (2018) was to determine if *Dionaea* pollinators would be preyed upon by the traps. They were not.

The inflorescence of *Dionaea* is an umbelliform cyme with 2 to 14 flowers on a long scape that arises from a small perennial rhizome (Smith 1929; Radford *et al.* 2010). Roberts and Oosting (1958) observed that the flowers of *Dionaea* begin opening at the terminal flower of inflorescences that bear an average of six flowers on a scape about 20-30 cm long, well away from the traps. They state that at the time a flower opens from its bud its anthers are shedding pollen. Approximately 24 hours later the stigma is receptive. They also performed experiments that indicated the flowers do not self-pollinate.

Roberts and Oosting (1958) suggested visitors that they observed on flowers as possible pollinators. These included “various beetles, small flies and possibly spiders”.

The much more thorough investigation of the pollinators of *Dionaea* by Youngsteadt *et al.* (2018) revealed that its major pollinators are the sweat bee *Augochlorella gratiosa* (Halictidae) which had the highest relative pollen abundance, and the longhorned beetle *Typocerus sinuatus* (Cerambycidae) and the checkered beetle *Trichodes apivorus* (Cleridae) which carried the largest pollen load.

Their study carefully documents the pollinator's identity and measures effectiveness but does not look at timing of pollination, the role in pollination of the changes in flower structure that result in protandry (Roberts & Oosting 1958), or other characteristics of the flower that are involved in pollination. Their efforts were concentrated on the insect pollinators.

The present report results from observations on *Dionaea* flowers made in the course of a quantitative study of captures by the traps. The observations include the timing of floral development and pollination of *Dionaea muscipula* flowers and the changes in flowers during anthesis.

Dionaea was introduced into the area around Hosford, Liberty County, Florida in 1973 or 1974 by a carnivorous plant collector and have thrived there in the Florida coastal plain savannas since that time. A different population of *Dionaea* was introduced independently 20 miles south of Hosford about 2003 in a coastal savanna area similar to the plant's native habitat in the Carolinas. These plants, growing on private land within the Apalachicola National Forest since 2003, were used in this study.¹

This study describes in detail the timing of the protandrous development of the *Dionaea* flowers and of pollinator visits. It also allows a comparison of pollination in the coastal savannas of the Florida Panhandle with those in the Carolinas.

Methods

Plants in a stand of *Dionaea muscipula* established near Sumatra, Florida on private land within the Apalachicola National Forest were observed while in flower between 4 May 2020 and 21 May 2020.

Video of a 24.5 × 15 cm area was recorded using a time-lapse mechanism to record 1-min videos every five minutes using the 1920 × 1080 video setting of a Bushnell NatureView CAM with a 460 mm close up lens. The camera was mounted horizontally, looking directly down on the flowers, using an RC Williams Co. TopView Quick-Mount. The camera mount held the camera firmly in place so that it could be set in the exact same location after changing the SD card. Thus, one of every five minutes was sampled during a 43-hour period.

The videos were then observed continuously with a VLC Media Player, noting any activity by visitors.

Flower development was observed in the time-lapse videos and the changes in form of the flowers over three days were noted. More detailed images of the flower development were recorded using a Celestron Handheld Digital Microscope Pro 5mp.

Ultraviolet photography of flowers from plants cultivated by Siegfried Hartmeyer was done using a Raytech Versalume UV-lamp with two glass filters for 254 nm and 366 nm. The fluorescence resulted from a 366 nm excitation and was photographed with an Olympus SH-2 camera.

Results and discussion

Anthesis began in the morning between 10:00 (EST) and noon.

First day flowers developed from buds that had swollen to about twice their previous size overnight (Figs. 1a, 1b) and then open in less than an hour during late morning (Figs. 1b, 1c). The anthers

¹ The neighboring Florida population in this study originated from seed, descended from plants from the Carolinas, broadcast over the savannah habitat in the Florida panhandle 15 to 17 years ago. The seeds descend from *Dionaea* plants grown in Virginia from seed originally harvested from the Carolinas about 40 to 50 years ago. All plants were from broadcast seed except for the transplanted plants mentioned in the text (Observed by Bill Scholl).

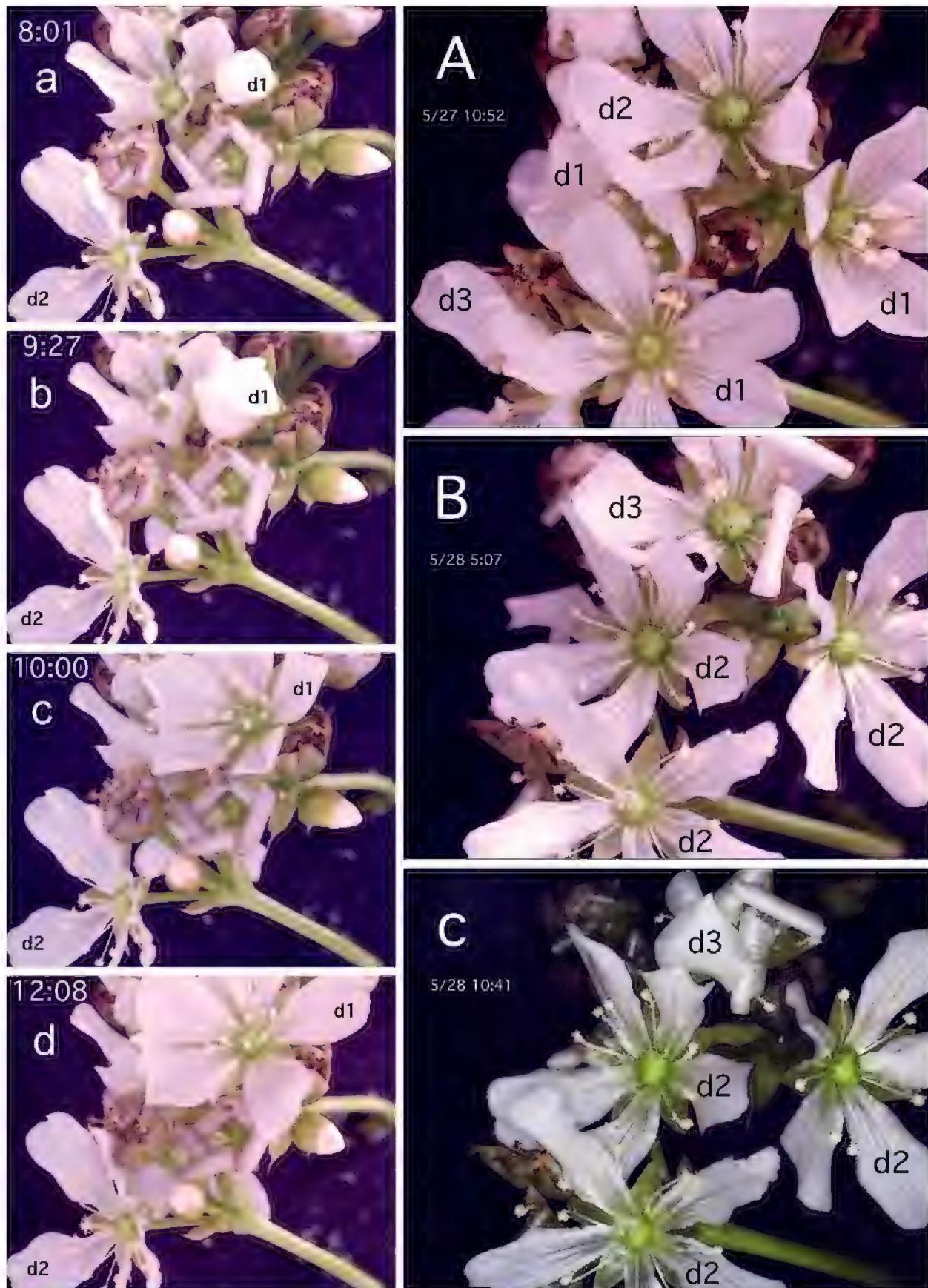


Figure 1: (left): Flower development: Time of photograph is given in the upper left corner in 24-hr time EST. Flowers opening from buds on day illustrated = d1. Flowers that opened previous day = d2. Note anther development on d1 flowers and stigma development on d2 flowers.

Figure 2: (right): Protandrous flower development: The date and time (24-hr time EST) is in the upper left-hand corner. This shows the same inflorescence on two different days, illustrating flowers as day-one flowers in A and day-two flowers in B and C. Note the differences between day-one flowers (d1) and day-two (d2) flowers in B and C. The day-2 flower in A is a day-3 flower in B and C.

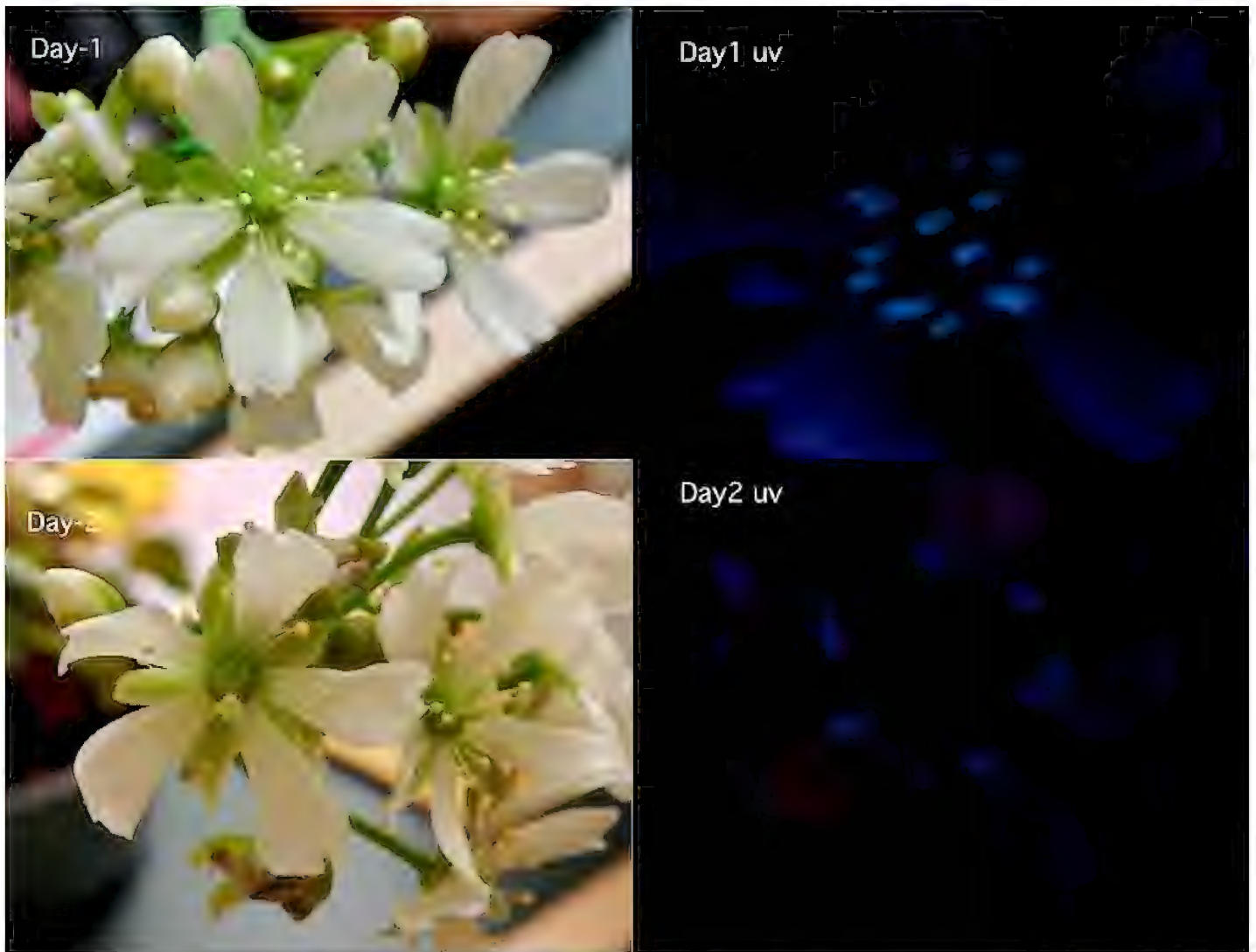


Figure 3: In the laboratory the petals of both day-one (top) and day-two (bottom) flowers only weakly reflect ultraviolet and show no patterns visible in these wavelengths. By contrast the anthers, probably due to fluorescence by the pollen, appear as a series of dots in the center of the day-one flower (top). The anthers of the day-two flowers (bottom) show as a weaker ring of dots. This ring is absent from flowers out of doors where the pollen is stripped from the anthers by insects.

dehisce about 45 min later (Fig. 1d). By 12:00 EST the flower is fully open and the five radially arranged petals are tilted slightly toward the center of the flower; the stamens are erect so that the anthers are arrayed over the center of the flower (Figs. 1d, 2A); and the style is short with the immature stigma appearing as a small green knob (Figs. 1d, 2A, 3 day 1). In the evening (about 16:00 EST) the stamens bend backward toward the petals and the petals move slightly upward. This results in the stamens being arrayed radially with two over each petal (Fig. 2B).

Second day flowers in the morning appeared unchanged from the previous evening except for the elongation of the style which bears a small, undeveloped stigma. Between 10:00-12:00 the stigma rapidly expands to about three times its previous diameter and presents a highly papillate surface (Fig. 1c and 1d).

Third day flowers appear similar to the previous evening except that the papillate stigmas are much wider and the petals are flexed further upward with the stamens pressed against them. At the end of the third day the petals and stamens deteriorate and fruit development begins (Figs. 2B, 2C).

Visits by insects to the flowers occurred between 11:30 and 18:00 EST with the exception of the small black wasp that once appeared shortly after 9:30. It was feeding on pollen remaining in a day-two flower.



Figure 4: Insect visitors: A. A green sweat bee (*Augochlorella* sp) working the nectar glands at the base of the petals of a flower while pushing against its stigma. B. A bumblebee (*Bombus* sp) taking nectar from the same flower. C. A thread-waisted wasp (~1.4 cm; Sphecidae) at nectar glands. D. A small wasp (~3 mm) visits the nectar glands of a flower (see arrow). E. A bee fly (Bombyliidae) probes a nectar gland at the base of a petal with its proboscis. F. A butterfly (Hesperiidae) rests on the petals of a flower while probing the nectar glands.

Six species of frequent visitors were observed repeatedly visiting flowers; two kinds of bees, two species of wasps, a species of bee fly, and one type of butterfly (Fig. 4). Several other small insects were occasionally seen resting on petals but did not approach anthers or stigmas.

The two bees were a green sweat bee (*Augochlorella* sp., Fig. 4A) and a bumblebee (*Bombus* sp., Fig. 4B). *Augochlorella gratiosa* was by far the most important pollinator of *Dionaea* in its native range in the Carolinas, accounting for a larger pollination index than the sum of all other pollinators combined, while *Bombus* was not reported as a pollinator (Youngsteadt *et al.* 2018). In the present study, in Florida, both bee species interacted vigorously with both the pollen-presenting day-one flowers and the stigma-receptive day-two flowers and both species of bee actively sought both nectar and pollen.

The two wasps were a thread-waisted wasp (~1.4 cm) (Sphecidae, Fig. 4C) and a small black wasp (~3 mm) (Fig. 4D). Both visited day-one and day-two flowers and touched both pollen bearing anthers and receptive stigmas. The thread-waisted wasp sipped nectar and moved deftly around the flowers performing all the actions a pollinator would but it is not clear that its smooth surface would carry pollen. The small wasp walked around the surface, sometimes eating pollen remaining on day-two anthers and sometimes sipping nectar. It touched both the stigma and anthers at times but the timing was not the same as the other visitors and their motions seemed helter-skelter. It is possible that they delivered a few pollen grains to a few receptive stigmas but they are not likely to be a major pollinator. Further investigation is necessary for both of these insects.

The bee fly and butterfly visited both day-one and day-two flowers. The hovering bee flies (Bombylidae, Fig. 4E) reached the nectar glands from the side with their long mouthparts, avoiding the stigmas, but sometimes coming in contact with the anthers. The butterflies (Hesperiidae, Fig. 4F), which sat on petals as they extracted nectar, had mouthparts that slipped past the anthers as well as the stigma. Both of these species are nectar thieves.

All species of insects that visited the flowers during anthesis were capable of both flight and of extracting nectar from the flowers. All six species of visitors visited both day-one, pollen bearing, and day-two receptive stigma bearing flowers. Bees and wasps made contact with both anthers and stigmas but the bee flies and butterflies introduced their long mouthparts from the side, avoiding the stigmas. The butterfly, which sat on several petals, had mouthparts that were long enough to slip past the anthers as well (Figs. 4E, 4F).

The timing of visits correlates perfectly with the availability of pollen and the receptivity of stigmas.

Comparison of pollinators with Youngsteadt *et al.* (2018)

The green sweat bee (*Augochlorella gratiosa*) was the major pollinator of *Dionaea* growing in its natural habitat studied by Youngsteadt *et al.* (2018) and a species of *Augochlorella* is clearly an important pollinator of the introduced Florida plants that we studied. Bumblebees (*Bombus* spp.) are not mentioned by Youngsteadt *et al.* (2018) although it is certainly an important pollinator in the Florida plants. The thread-waisted wasp (Sphecidae) is also not mentioned but this may be because it was a visitor that carried no pollen and thus did not make their list of pollinators. The same may be true of all visitors we observed other than the two bees. By contrast we observed none of the beetles that were such an important part of the pollination biology of *Dionaea* in the Carolinas.

Although the habitats are very similar, several caveats remain. First, the fauna in the Florida panhandle and the Carolinas are almost certainly not exactly the same. Second, our sample size is smaller than in the more extensive study of Youngsteadt *et al.* (2018).

Floral development in *Dionaea* pollen biology

The terminal flowers of the inflorescence develop first with flowers on subordinate branches developing sequentially.

The protandrous sequence of flower opening, described previously, has individual flowers with viable pollen the first day and receptive stigmas the second. This explains the self-incompatibility of flowers observed by Roberts and Oosting (1958), provided that the pollen remaining on the anthers is not viable the second day.

Our observations on the inflorescence and flower development agree with the brief, limited, descriptions by C.M. Smith (1929) and Roberts and Oosting (1958) except for Roberts and Oosting's statement that a first day flower "immediately begins shedding pollen" upon opening. There is actually a period of about 45 min between the opening of a bud and the dehiscence of the anthers.

The result of the developmental sequence of *Dionaea* flowers is that day-one flowers have anthers bearing free pollen, displayed prominently in the center of the flower in late morning, about 11:30 EST on the first day. Approximately 24 hours later at about 11:30 EST the anthers of the flower, now in day-two form, are away from the center of the flower and the newly enlarged stigma occupies a prominent place in the center. The anthers and stigmas are both optimally positioned for pollination on successive days.

Attractants

Pollinators drawn to the pollen-laden anthers of the day-one flowers are rewarded with both pollen and nectar. The day-two flowers, usually stripped of pollen, still provide a nectar reward. The flowers are also conspicuous, with attractants common to many flowers such as a radially symmetrical array of petals and stamens, and possibly a scent during the period of anthesis.

Pollen is a reward that is prominently displayed on day one with the dehisced anthers appearing in ultraviolet as a cluster of dots in the center of the flower (Fig. 3). Pollen has usually been stripped by day two but if it remains, the positioning of the anthers to the side would result in a circle of dots on the corolla in ultraviolet (Fig. 3).

Nectar glands at the base of the petals are active attractants on both day-one and day-two. The bees and wasps (Figs. 4A, 4B, 4C, 4D) take nectar from the base of the petals and the nectar glands are clearly probed by the long proboscis of bee flies visiting the flowers (Fig. 4E).

Petal and Stamen display is a feature that changes gradually as the flowers age.

Five bright white petals with about eight vertical gray veins on each petal radiate from the center of the flower. There is only a small amount of ultraviolet fluorescence from the petals (Fig. 3). On the evening of day-one and in day-two flowers when the stamens move toward the petals their filaments add a new set of radiating lines to the flowers' appearance. In the laboratory the pollen adhering to the anthers still reflects a radial pattern but in the field the anthers have typically been stripped of their pollen. On day two and day three the broad white stigma stands out in the center of the flower.

Scent attractive to visitors has not been reported in *Dionaea* flowers but several observers reported smelling an odor during the period of pollination. This needs further investigation.

Seeds

The population of *Dionaea* in the present pollination study produces viable seeds. The population originated from 3 or 4 plants transplanted from a neighboring Florida population about fifteen

years ago. The population has subsequently spread over about 1.5 m², probably from its own seed, since the plants are varying size and characteristics, as expected from a sexually reproduced population. The plants produce abundant seed every year (Scholl, Pers. obs., 2020).

The pollinators in this study clearly are causing successful pollinations resulting in viable seeds.

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Since 2004 I have been hybridising *Sarracenia*, and want to show the variations that can arise with complex hybrids.

Sarracenia courtii × (*alata* × *willisii*)

These two plants look completely different to one another. *Sarracenia courtii* produces many flowers simultaneously, which is useful when hybridising. Interestingly, while most of the offspring had similar shaped lids, there were differences. Some had decumbent thin dark red pitchers that widens towards the top, with an open rounded lid (Fig. 1B). Others were similar form, but with lighter, red-veined pitchers (Fig. 1A). Yet others resembled light, red-veined *S. minor*, but with a closed lid.

Sarracenia courtii × ‘Evendine’

While all the resulting plants had narrow and semi-decumbent pitchers with opened ruffled lids, the pigmentation was variable. Pitchers ranged from olive green with red veining and some light pink colouration between the veins on the lid, to very dark red to purple pitchers. Pitchers tend to cluster similar to *S. purpurea* and is a strong hybrid (Fig. 1D).

Sarracenia catesbaei × ‘Evendine’

I wanted to produce a plant similar to a dark purple *S. catesbaei* with some interesting colouration on the lid. Most of the seedlings are green or light red, turning very dark red, with frilly lids; the pitcher interior is green with red veins; fenestrations are on the upper pitcher and lid. One seedling had larger, semi-decumbent pitchers that are green, with a lid coloured similar to the *S.* ‘Evendine’ parent.

Sarracenia courtii × *flava* var. *rubricorpora* and *Sarracenia courtii* × *umlauftiana*

Interestingly, results from these two hybrids were uniform. The *S. flava* hybrids were all semi-decumbent and dark red to purple in bright sunlight, whereas the lid is a lovely wavy shape (Fig. 1C). Minor variation occurred in the pitcher and lid dimensions and colouration. Another plant produces almost the same shaped pitchers, except these are darker with smaller lids. The second hybrid is shown in Fig. 2C.

Sarracenia (*alata* × *psittacina*) × (*alata* × *willisii*)

One of my favourite hybrids is the open lid form of *S. alata* × *psittacina*. I have a closed lid version with beautiful dark red pitchers with white fenestrations and some red veining. It is a very strong plant and multiplies readily. My aim was to produce an open lid form of *S. alata* × *psittacina* except with darker pitchers. Three different variations resulted from the cross. The first was a plant that has the same size of *S. alata* × *psittacina* except with an open lid and lighter colour, the second also has an open lid except it is much thinner and very dark purple (Fig. 2A), and the third (only a single incidence) has the exact same closed lid shape as the ovary parent except pitchers seem to be a darker red and have less fenestrations.

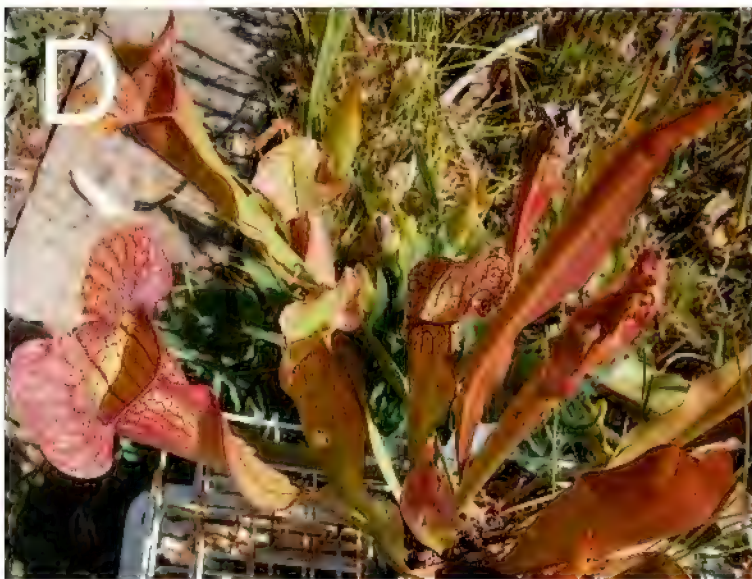


Figure 1: A, B: *Sarracenia courtii* x (*alata* x *willisii*); C: *S. courtii* x *flava* var. *rubricorpora*; D: *S. courtii* x 'Evendine'.

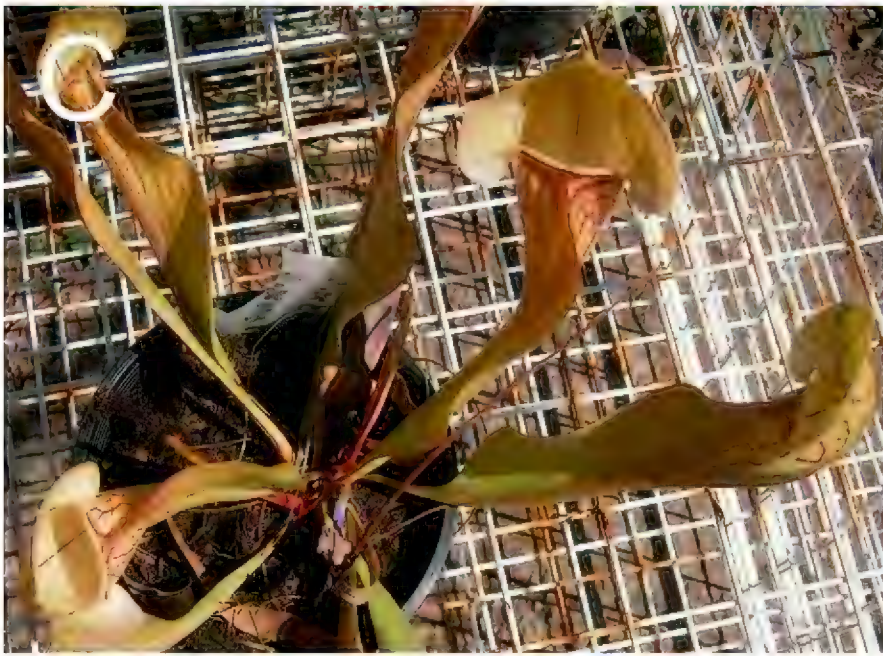


Figure 2: A: *Sarracenia* (*alata* x *psittacina*) x (*alata* x *willisii*); B: *S.* (*minor* x (*psittacina* x *purpurea* subsp. *purpurea* var. *heterophylla*)) x (*flava* x *rubra* subsp. *alabamensis*); C: *S. courtii* x *umlauftiana*; D, E: *S. catesbaei* x (*leucophylla* x *mitchelliana*).

Sarracenia (*minor* × (*psittacina* × *purpurea* subsp. *purpurea* var. *heterophylla*)) ×
(*rubra* subsp. *alabamensis* × *flava*)

The seed parent in this cross does not resemble *S. psittacina* at all; it has slightly inflated pitchers (light green to yellow and red-veined), with influence in the lid shape from some *S. minor*. The cross of this with *S. rubra* subsp. *alabamensis* × *flava* resulted in a plant that is mostly unchanged, except that the lid and pitcher bodies are influenced by the pollen parent; also, the pitchers develop a dark red colour as they age in bright sunlight (Fig. 2B).

Sarracenia (*leucophylla* × *oreophila*) × (*leucophylla* × *mitchelliana*)

After reading a wonderful paper by Clemesha (1979) where he attempted to produce a strong and beautiful *S. leucophylla* backcross, I wanted to produce a plant that looked similar to *S. leucophylla* that would produce more offshoots and pitchers. The pollen parent has tall thin green pitchers, white on the lid and top section of the pitcher, with prominent pink venation. The lids are sometimes slightly curved and this plant produces beautiful pitchers throughout the entire growing season. The seed parent is very tall and mostly green with very light red venation and have a small number of very faint white fenestrations on the lid, which has a similar ruffled shape as the lid of *S. leucophylla*. *Sarracenia leucophylla* × *oreophila* usually produces beautiful pitchers in spring and early autumn, producing leaf blades as the *S. leucophylla* parent during summer.

The resulting seedlings have the appearance of tall *S. leucophylla* plants with white lids and upper pitchers (One plant produces folded lids similar to the pollen parent.) The hybrid produces offshoots easily and produces light red petals.

Sarracenia catesbaei × (*leucophylla* × *mitchelliana*)

When crossing *S. catesbaei* with *S. leucophylla* × *mitchelliana*, I intended to produce a hybrid similar to *S. catesbaei* but with some bright white fenestrations on the lid. Instead, I got a hybrid shaped like *S. catesbaei*, green in the lower half of the pitcher and bright white above, veined pink throughout (Fig. 2D). This hybrid unusually produces pure white petals in early spring, a characteristic neither parent hybrid possesses (Fig. 2E). The origin of the white petals is unknown. Pitchers currently are 30 cm in height and the plant is approximately in its tenth year of growth and so far, seems to be smaller in size relative to the large *S. catesbaei* parent used to produce this hybrid.

Sarracenia (*oreophila* × *purpurea*) × *purpurea* selfing

A commercially available plant (with the informal name “Paradisica”) is a hybrid composed of *S. (oreophila* × *purpurea*) × *purpurea*. Many years ago, it self-seeded and most of the offspring resemble parent plant, but some have light green pitchers and one plant a very light green yellow colour.

Final thoughts and conclusion

While it is possible to hybridise plants to varying extents both in nature and horticulturally, I think excessive hybridisation can produce plants that are interesting in shape and colour but may not be as tough as early first-generation hybrids or backcrosses with one of its ancestral species. On

the other hand, F1 and some F2 backcrosses do produce some very nice plants that have beautiful colouration and are strong.

It is common knowledge among growers and plant hobbyists that when plants are hybridised and there are more than two species involved in the crossing, the seedlings begin to display some variation in shape or colour, or both. As shown in my hybridisation experiments, crossing complex hybrids did produce some beautiful and unusual shaped plants and the seedlings from many of these crossings did vary. These included differences in either lid shape and colour.

References

Clemesha, S. 1979. *Sarracenia* species in Australia. Carniv. Pl. Newslett. 8(4): 106-109,114.

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HYDROPONIC CULTURE OF *DROSOPHYLLUM LUSITANICUM*

JEONG-PIL LEE (이정필) • Seoul • Republic of Korea • paine6@naver.com

I raise various insectivorous plants as a hobby in Korea, and I work with the nickname Marshy Lander. There is a rumor that *Drosophyllum lusitanicum* is difficult to grow in Korea.

In December 2018, my friend Jun-su Kim (김준수) gave me some *Drosophyllum* seeds. The seeds germinated and I have been growing the plants. As the plants grew, I had trouble because my living environment was too small to grow big plants and I needed to grow the plants in a smaller space. So, after some trial and error of using a hydroponic method, the plants grew well and I succeeded in obtaining seeds.

Here is my method

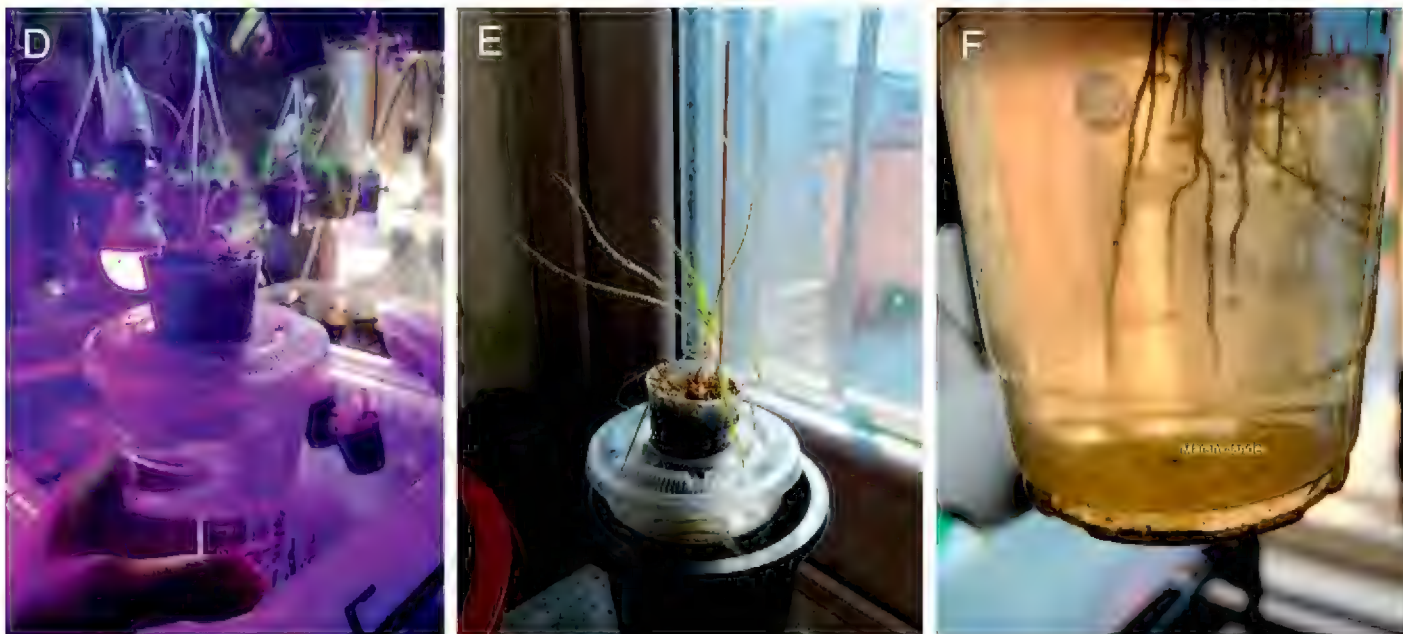
1. Germinate *Drosophyllum* seeds and initially grow the seedlings in a seed starting tray.



2. Remove the seedlings and transplant them into small pots (A). The small pots should allow roots to emerge, so make a big hole in the bottom (B). Let the first root come out of the hole. I put the small pot in a common take-out coffee cup (C). Fill the take-out coffee cup with pure water. Roots that come out of the small pot hole must meet the water.



3. In Korea, winter is very cold, so I grow the plants indoors (D, E). Moss often grows in a transparent cup, so it was placed in a black cup (E). The roots continue to grow and reach the bottom of the cup (F). When the weather becomes warmer, the plants can be moved outside.



4. When the roots become too long, the bottom irrigation cup is replaced with a deep bottle (G). The sunshine outdoors would make the water in the bottle too hot, so to lower the temperature, a cloth was applied and the bottom was irrigated (H). Is hydroponics an alternative? Take a look at the size of the roots (I).



5. The mature plant flowered outdoors (J). When the ovary develops (K) and the inside becomes transparent brown (L), collect seeds (M).



The hydroponic plants should be protected from rain. When it rains, water fills the bottom container and the plants tend to rot and die.

I hope that cp growers around the world will try *Drosophyllum* hydroponics. My experience is that *Drosophyllum* is not a difficult plant to grow.



INSECTIVORE ART IN TRANSIT

CAROLYN BRAAKSMA • and • CHRIS LANGE • Charlotte • North Carolina • USA • braaksma.design@gmail.com • clange@charlottenc.gov

Art reflects nature in a monumental way on the new section of the LYNX Blue Line in Charlotte, North Carolina. Forty-five concrete retaining walls that cumulatively make up 4 miles (6.4 km) of the 9.6-mile (15.5-km) light rail extension project display a wide variety of carnivorous plants and orchids that are indigenous to the Carolinas. Denver artist Carolyn Braaksma was commissioned by [Charlotte Area Transit System] CATS Art in Transit to create the patterns for a variety of wall types and sizes, including enhancing four rail bridges connecting to the art walls.





In the spring of 2013, Braaksma spent three months at the McColl Center for Visual Art in a CATS-sponsored residency to provide her access to the project team and the Charlotte community during the Blue Line Extension design phase. Early in the residency, she visited UNC Charlotte's Botanical Gardens, where she learned that the Carolinas were home to many orchids and indigenous insectivores including Pitcher Plant varieties (*Sarracenia*), Venus flytrap (*Dionaea*), Sundews (*Drosera*) and Bladderworts (*Utricularia*). These plants became the inspiration for the wall patterns. Over the course of her residency, she shared her art process with the public and met with area students as she created her large-scale drawings that would be translated into concrete relief on the project walls. She carved her first full-sized prototype of Calico Kudzu, mapped out over 300,000 ft² (27,871 m²) of wall designs, and designed her green leaf railings for the four bridges. The bridge girders, colored green as specified by the artist, visually tie her railings to the girders under each bridge span. Two of the bridges are supported by her Pitcher Plant Bridge Piers; each pier measures 25 ft (7.6 m) across and 18 ft (5.5 m) high.

Braaksma's wall layouts and naming of the walls were also influenced by textile patterns. Her panel walls consist of a module with seven or four repeated columns divided by a Sundew or Pitcher Plant pilaster. By rotating her panels within each seven or four columns, she increased the variations throughout the many miles of art. In a single 4.5 × 5 ft (1.4 × 1.5 m) panel, a tiny recognizable insectivore like the Venus flytrap is depicted in macro proportions. The imagery is based on indigenous North Carolina plant life while the art wall titles capture both her plant and textile references to further intrigue the viewers.

For each of her 17 different designs, Braaksma spent over a year carving her full-scale prototypes, ranging in size from 5 × 5 ft (1.5 × 1.5 m) to 20 × 20 ft (6.1 × 6.1 m). She managed her subcontractor in Denver during the production of the 17 master molds produced from her prototypes. The masters were then provided to CATS contractors to fabricate the form liners for concrete and the subsequent building of the walls, which occurred from 2015 until the line opened in March 2018.

This is the first time to our knowledge carnivorous plants have been incorporated into retaining wall public art motifs. Part of the motivation was to use local plants as sources of inspiration for the art expressed in the project as is often the notion with Braaksma's designs.

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NEW CULTIVARS

Keywords: cultivar, *Cephalotus* ‘Kai’s Error’, *Dionaea* ‘CCCP Destruction’, *Nepenthes* ‘Pennywise’, *Nepenthes* ‘Simon’, *Sarracenia* ‘Caitrin Claire’, *Sarracenia* ‘Dr M.’, *Sarracenia* ‘Red Closed Trap’, *Genlisea hispidula* ‘Odin’.

Abstract: Eight new carnivorous plant cultivars are named and described: *Cephalotus* ‘Kai’s Error’, *Dionaea* ‘CCCP Destruction’, *Nepenthes* ‘Pennywise’, *Nepenthes* ‘Simon’, *Sarracenia* ‘Caitrin Claire’, *Sarracenia* ‘Dr M.’, *Sarracenia* ‘Red Closed Trap’, *Genlisea hispidula* ‘Odin’.

Dionaea ‘CCCP Destruction’

Submitted: 8 September 2020

Dionaea ‘CCCP Destruction’ (Fig. 1) was propagated by seed from unknown parentage and selected on 31 May 2018 by Craig Heath (Crazy Craig’s Carnivorous Plants). Differing significantly from *Dionaea* ‘Master of Disaster’, *Dionaea* ‘Doomsday’, or *Dionaea* ‘Cthugha’, *Dionaea* ‘CCCP Destruction’ has a round tubular trap base with 3 to 4 curved leaf openings surrounded by an unformed leaf structure. Teeth are long and distorted. Each trap is non-functional for trapping insects. Petioles are up to 2.5 cm long, traps are 1.8 cm wide, cilia 0.5 cm long.

The name ‘Destruction’ is for its confusing bizarre leaf structure.

Dionaea ‘CCCP Destruction’ must only be propagated vegetatively to preserve the wildness characteristic of the cultivar.

—CRAIG HEATH • Crazy Craig’s Carnivorous Plants • Lorton • Virginia • USA • craigsterh@msn.com



Figure 1: *Dionaea* ‘CCCP Destruction’.

Cephalotus ‘Kai’s Error’

Submitted: 18 November 2020

In 2017, I made a swap of *Cephalotus follicularis* plants with Kai Becker, another German grower. I got a very unique plant from him which was seed grown by himself in 2011. This plant normally made no pitchers but only small non-carnivorous lanceolate leaves (Fig. 2A). Only from time to time it starts to make a pitcher, which is often deformed and stays very very little (Fig. 2C). Kai gave me the plant under the name *Cephalotus* “Error” and told me that he first named it *Cephalotus* “Eden’s Child Clone 3”.

The parentage is *Cephalotus* ‘Eden Black’ × self. The plant, which looks a bit like a mixture of a miniature palm tree and a fern, stays mostly green in summer, but with cold temperatures it becomes dark maroon (Fig. 2A). It produces a normal peduncle, which has fewer flowers than the one from a normal *Cephalotus* plant (Fig. 2B). I want to name the plant *Cephalotus* ‘Kai’s Error’ to honor the breeder. My growing experience for this plant is similar to what it is for all other *Cephalotus* plants. Maybe *C.* ‘Kai’s Error’ is happier with less water than you should give to a “normal” *Cephalotus* plant.

To preserve the unique characteristics of the plant, propagation must be vegetative. The plant made bastard branches which can be separated from the rest of the plant and it can also be propagated by root cuttings or by leaf cuttings which are very tricky because the leaves are thin and small with only a very short stalk. A lot of leaves failed to produce new plants. This cultivar is a very slow grower.

—ALEXANDER FISCH • Aachen • Germany • fischermans3@yahoo.de

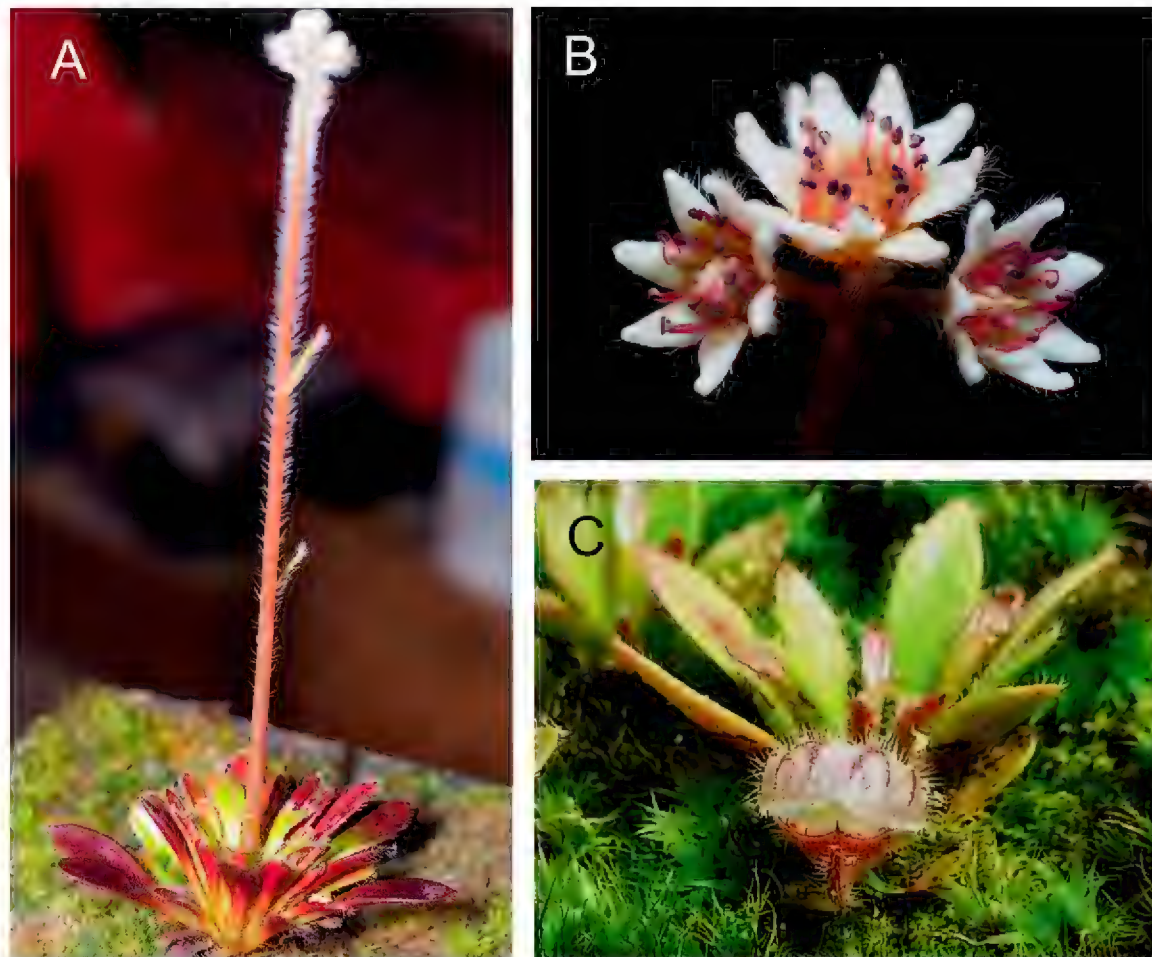


Figure 2: *Cephalotus* ‘Kai’s Error’. (A) Plant, (B) flower, (C) small deformed pitcher.

Genlisea hispidula ‘Odin’

Submitted: 19 September 2020

Among numerous clones of *Genlisea hispidula* in my collection, this selection is as yet unsurpassed in quality. It has several desirable features of note: first and foremost, the photosynthetic leaves form comparatively large rosettes (approximately 30 mm in diameter) of beautifully proportioned, obovate leaves (approximately 15 mm in length and 8 mm at their broadest) with an unusually glossy surface (Fig. 3A). While other clones of this species often produce asymmetrical and sprawling leaves, *Genlisea hispidula* ‘Odin’ produces beautifully neat and compact leaves that self-support above the soil surface, rather than resting thereon. These leaves are additionally of remarkably regular size, rarely falling outwith the specified parameters, and are produced abundantly, leading to an overall extraordinarily compact “neatness” in the rosettes, which characterises *G.* ‘Odin’. Flowers are borne on inflorescences approximately 90-135 mm in length and are of high quality for this species (Fig. 3B). The lower corolla is a vibrant pastel lilac (RHS 91C) with a magenta (RHS N78B) “collar” on the palate, which is profusely and notably interspersed with darker glandular trichomes, a feature far more prominent in this selection than in other clones. The interior of the “collar” and the upper corolla are creamy-white (RHS 18C). The spur is exceptionally broad and extends notably far past the lower corolla lobes, ending in a conspicuous yellow (RHS 1B) tip. Flowers are 10-12 mm in width and 12-15 mm in height. Overall, this selection has been made for its compact and “neat” growth, and its exemplary flowers.

Named for my friend Odin, from whom I received the plant.

Reproduction must be by vegetative means only.

—FRASER ANDERSON • Livingston • West Lothian • Scotland • fwhanderson01@aol.com



Figure 3: (A) *Genlisea hispidula* ‘Odin’ plants; (B) flower.

Sarracenia 'Caitrin Claire'

Submitted: 9 September 2020

Sarracenia 'Caitrin Claire' is a complex *S.* × *moorei*, the result of crossing *S.* 'Hot Lips' with *S.* 'Adrian Slack'. Phil Faulisi performed the cross in 2014 and gave seeds to Trey Hale, who germinated several small pots of seedlings. Trey then gifted me one of these community pots of baby plants on the occasion of my birthday in April 2015. By fall 2015, this clone's stark coloration already distinguished it from its siblings.

Sarracenia 'Caitrin Claire' forms elegant and exceptionally colored traps. The mouth is flaring with a well-developed, spouted peristome and is entirely glowing candy red with darker red veins and scattered white areolae (Fig. 4). Likewise, the outer upper tube displays white areolae with red veins. It is the lid, however, that truly sets this clone apart. It is large, held high above the mouth by the slender neck, and on its upper surface is crystalline, bright snow-white shot through with bold blood-red veins. The lid veins do not bleed into the white interstices and the traps maintain their outstanding contrast until senescence. The lid possesses an elegantly upturned tip and, on some pitchers, may be charmingly undulate. The lid underside is also white, but so densely veined in red as to appear pink. The plant consistently and rapidly attains this appearance outdoors and does not require greenhouse conditions to develop proper color.

Sarracenia 'Caitrin Claire' has formed pitchers up to 61 cm in height so far, though I suspect it is capable of growing taller than this. The largest pitchers emerge in spring, followed by smaller traps and phyllodia in late summer. The flowers are a deep pinkish red.

This clone shows much influence from its famous parent *S.* 'Adrian Slack', but is distinct in important ways: First, it displays much greater quantity and quality of color under my outdoor growing conditions, glowing as if electrified while 'Adrian Slack' produces comparatively subtle pastel hues only. Second, *S.* 'Caitrin Claire' is hardier. In my experience, *S.* 'Adrian Slack' grows smallish spring traps outdoors in Oregon and appears stressed, seeming to attain impressive development only in greenhouses or very warm spring climates. In contrast, *S.* 'Caitrin Claire' is consistently robust and excellent in our cooler springtime. It also performs and colors well in hotter, long-season climates (TH, pers. comm.), showing its adaptability and vigor.

'Caitrin Claire' is named for my lovely sister, and should only be propagated by vegetative means in order to preserve its unique attributes.

—CALEN HALL • Portland • Oregon • USA • calen.hall@gmail.com

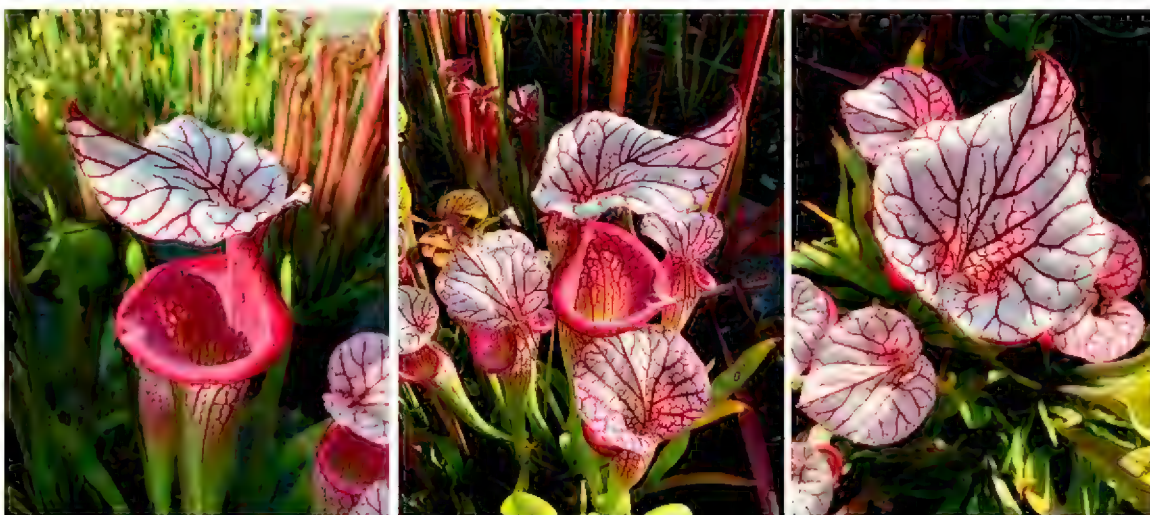


Figure 4: *Sarracenia* 'Caitrin Claire'.

Sarracenia ‘Dr M.’

Submitted: 10 September 2020

Larry Mellichamp has been a mentor to me for decades. His work with *Sarracenia* hybrids encouraged my efforts in this endeavor as I have followed my own breeding goals. His warmth and wisdom have been evident in every conversation we have had over the years. It is a great honor to have his endorsement in naming one of my hybrid creations for Larry or “Dr M” as his students warmly refer to him.

Sarracenia ‘Dr M.’ has several characteristics that I love and make it a superior cultivar (Fig. 5). It is compact, the traps are stiff and resist spreading or collapsing. The growth habit has an incurved vase shape with prolific white and red veined traps that exhibit formal and symmetrical trap production reaching 30-45 cm high and 5-8 cm wide.

The most striking feature of *Sarracenia* ‘Dr M.’ is how the plant holds its traps through the season. The previous year’s traps are still beautiful when the plant starts flowering in spring, making this plant look fresh year-round with its gorgeous color and configuration.

The plant is a cross of *S. (courtii* × *leucophylla*) with a lost label white hybrid which looks to contain *S. leucophylla*, *S. psittacina*, and *S. rubra*. It is the influence of the *S. psittacina* from the *S. courtii* that makes this plant possible. The closed hood of most first-generation *S.* × *psittacina* hybrids do not please most people, but one more cross with a plant of more normal structure like *S. leucophylla* or *S. flava* can open the pitchers up to produce striking and beautiful hybrids. I used *S. purpurea* var. *purpurea* as the other parent of the *S. courtii* and it is very cold tolerant.

I had hoped that *S. leucophylla* coloring could be impressed upon a form that was shorter and clumpier than most *S. leucophylla* and shows better in spring when plant nurseries sell more plants than in the fall when the species peak in foliage production.

The last few years I have been looking for a plant worthy of naming for Larry. I feel this cultivar is very special and will be well regarded in the trade.

This one is for you, Larry.

—JERRY ADDINGTON • Courting Frogs Nursery • Stanwood • Washington • USA • jerry@courtingfrogs.com



Figure 5: *Sarracenia* ‘Dr M.’ plant and flower.

Sarracenia 'Red Closed Trap'

Submitted: 10 September 2020

Sarracenia 'Red Closed Trap' is a *Sarracenia mitchelliana* with a very dark cap tending to brown and it also has small white dots (Fig. 6A). The veins of the pitcher stretch below the top the half of the pitcher and are a very dark color. There is a mutation that produces laterally compressed pitchers with an almost closed opening (Fig. 6B). This mutation tends to be expressed especially in middle age, but also in adulthood it will make some traps with mutation. Plants are 15-20 cm tall (Fig. 7).

This plant was obtained 23 August 2018.

The name 'Red Closed Trap' is from the shape and color of mutant traps.

Propagation should be by vegetative methods.

—MATTIA CHINAGLIA • 11 Melegnano • Italy • mattia.chinaglia05@gmail.com



Figure 6: (A) Adult pitcher without mutation. (B) Adult pitcher with mutation.



Figure 7: *Sarracenia* 'Red Closed Trap' plant.

Nepenthes ‘Pennywise’

Submitted: 23 October 2020

In early 2017, seeds which Nicholas LeBlanc sold me in late 2016 yielded an unusually robust plant. It advanced from a cell tray to a gallon pot in under a year and a half, by which time its leaf span was over 30 cm. In late 2018, upon introducing it to a 5 gal. bucket, leaf span stretched to over a meter across, adding over a meter in height some months later.

The pedigree is *Nepenthes* (*kampotiana* × *maxima*) × (*eymae* × *ephippiata*). Nicholas thinks that the *N. kampotiana* clone used by Bruce Bednar in the 1980s may have been what we now know to be *N. smilesii*. The mother plant, *N. eymae* × *ephippiata*, is a wonderful clone bred by Joel Stern.

A specimen of *Nepenthes* ‘Pennywise’ is a show-stopper (Fig. 8). When left untrimmed, it may have up to 20+ traps on it at any given time, retaining them for up to nine months before expiring. Leaves are broad and elegant.

Its growth demeanor is “aggressively vigorous”. It often grows with insatiable speed, especially as it begins to vine. Desirably, it will produce numerous rosetted traps before doing so. Nodes along the vines are precociously well-developed when inactive, activating explosively: multiple nodes may fill out into lush growth along a single damaged vine, an attractive horticultural trait.

Traps and foliage take after the father, with much of the vigor of the mother. The weird and wonderful lowers are leathery, slightly pubescent, and raspberry-red, with plenty of splotching on a waxy yellow interior, and red-yellow striped and kinky peristomes that bend over the edge of gaping, irregularly warped, narrowly ovoid orifices. Lids are enormous, flat or slightly vaulted. Intermediate and upper traps are absolutely beautiful – hovering, goblet-shaped, rigid, luminous yellow lanterns with richly pigmented interiors and a generous lid. It thrives under all manner of artificial lights or windowsills in household conditions. Copious offerings of orally applied fertilizer and slaughterhouse offal appease and embolden it to grow greater still.

A flesh-eating, overgrown monstrosity, with plentiful and obscene gluttonous gullets hanging pendulously, *Nepenthes* ‘Pennywise’ is more than a little unsettling. Illuminated under harsh light in the corner of my basement, it looks for all the world like alien spawn. I was inspired to invoke the name of the disturbing demon clown that feeds upon the souls of children.

‘Pennywise’ is male. Its propagation must be done vegetatively to maintain its unique genetic attributes. It is suspected by some that the plant may be polyploid.

—CARSON TREXLER • Portland • Oregon • USA • carson.a.trexler@gmail.com



Figure 8: *Nepenthes* ‘Pennywise’ (A) plant, (B) lower pitchers, (C) upper pitcher.

Nepenthes 'Simon'

Submitted: 17 November 2020

I obtained several seed-grown Borneo Exotics plants of *Nepenthes ventricosa* × *N. hamata* when they were first released around 2010/2011, and ended up keeping just one of them for its exceptional pitcher coloration. I named that plant Simon. It is a confirmed male plant. In order to maintain this habit within the cultivar, the plant must be propagated vegetatively and has been in distribution for several years as rooted stem cuttings.



Figure 9: Amplexicaul leaf attachment and red/purple stem with red leaf midrib.

Leaves are approx. 12 cm × 2 cm and green with red midrib under sufficient lighting (Fig. 9), and have amplexicaul attachment to the stem similar to *N. hamata* growth habit. Lower pitchers (Fig.

10) are up to 15 cm length by approx. 4 cm diameter and chartreuse yellow with bright red colored spots and red ribbed teeth on the peristome. Upper pitchers (Fig. 11) have approximately the same sizes but with a more bulbous *N. ventricosa*-based shape and the same color as lowers except with fainter red spots and fainter red between teeth ribs. Lids are held upright on the pitchers similar to *N. hamata*. The pitchers are glabrous, with clear sticky secretions from nectar glands mainly distributed on the upper outsides of the pitchers, and black digestive glands are visible on the bottoms of the insides of the pitchers. Leaves and stem also have nectar glands present. The stem turns red to almost purple with sufficient lighting.

Once established and twining, I noticed it started displaying a bifurcating growth habit (Fig. 12) which I have not seen out of any other *Nepenthes*. *N.* 'Simon' bifurcates its growth point to split off into two equally vigorous heads, and occasionally will bifurcate leaf veins and tendrils as well.

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Figure 10: Lower pitchers exhibiting bright red coloration. Note upright lid at angle (A) similar to *Nepenthes hamata* pitchers but lack the filaments on lid. Tendrils readily loop (B).



Figure 11: Glands on outside (A) and inside (B) of an upper pitcher. Nectar glands are also present on leaves. Note the spots are fainter red than in lower pitchers.



Figure 12: Bifurcation habit is present spontaneously and supports ongoing growth in stem (A) and also happens in leaves (B).

CARNIVOROUS PLANT CULTIVAR NAMES AND PATENTS

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Over the years, several carnivorous plants have been patented in a number of countries. This has resulted in some confusion about patents and registered names of carnivorous plants. Here is a short clarification.

Cultivar **plants** are not registered whatsoever. Established **names** of cultivars may be registered. This is effected only and exclusively by inclusion of the name in the International Register that is governed by the appropriate International Cultivar Registration Authority (ICRA) accredited with the International Society for Horticultural Science (ISHS).

In the case of carnivorous plants, the appropriate ICRA is the ICPS, nothing else. The publication of a new cultivar name can only be effected by (hard copy) print. Electronic publication, especially if ephemeral, is definitely not suitable.

Please note that a cultivar name, in order to be established, must be free for everyone to use worldwide. It must thus be different from any trademarks (which may exist for the same plant). Usually patents are granted for certain varieties (not cultivars) that should be sold under a certain proprietary brand name (trademark). Such names are not cultivar names and cannot be registered (they cannot be established because they are not free for everyone to use worldwide).

Patents and trademarks are national competence, so they are valid and can be enforced only in the country that granted them. Both are tools to protect the originator's market exclusivity (within certain limits).

Cultivar name registration is of immediate, global relevance to everyone who cares (no enforcement beyond common understanding) for horticulture and the International Code of Nomenclature for Cultivated Plants (ICNCP). It serves to facilitate identification of and to provide some basic information on cultivars and the criteria to distinguish them.

LITERATURE REVIEW

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Mathieson, M.T., and Thompson, S.L. 2020. *Drosera buubugujin* M.T.Mathieson (Droseraceae, *Drosera* section *Prolifera* C.T.White), a spectacular new species of sundew from the Cape York Peninsula bioregion. *Austrobaileya* 10(4): 549-557.

This novelty pushes the (known) northern limit of *D. sect. Prolifera* by more than 100 km. While they are geographically nearest to *D. prolifera*, the plants resemble *D. schizandra* so much that they could be conspecific. Unfortunately, the plants are so difficult to access that no genetic or chemical investigation that could test this hypothesis appears feasible in the near future.

BOOK REVIEW

Liu, A., and DiPietro, D. 2020. *Drosera* of the New Jersey Pinelands. Softcover, 156 + XIV pp., ISBN: 13-978-1889878-56-0.

Brit Press. \$35 + shipping, from <https://shop.brit.org/>

Reviewed by Barry Rice

Many many years ago, a friend in New York City was getting married, and asked me to serve as his best man. What an honor! I travelled across the country, to New York City for the event.

After the wedding, a long string of parties was scheduled. But instead of attending them, I befuddled (and no doubt offended) my friend's family when I packed my rental car and raced out of the city!

Why would I do such a thing? Because, of course, I was within striking distance of the New Jersey Pine Barrens! And so, midmorning the day after the wedding (while my cohorts were sleeping off hangovers) I was in the Barrens, in stunned ecstatic shock and delight, staring at the first carnivorous plants I had ever seen in the wild.

Really—that's the story of my first. And it is why I have a special, emotional connection to the New Jersey Pine Barrens. It also gives context to why I was thrilled to learn that a carnivorous plant book had been written about the Barrens. But I was also concerned...would it do the Barrens justice?

I am happy to say it does!

If you don't know, the New Jersey Pine Barrens (which is more or less interchangeably referred to as the New Jersey Pinelands National Reserve), is a large region spanning several counties in New Jersey. This Atlantic Coastal Pine Barrens ecoregion is characterized by sandy, nutrient poor soils and frequent fires. This results in stunted, dwarf forests of *Pinus rigida* (pitch pine) and *Quercus marilandica* (blackjack oak), often not much taller than a human. The streams flow slowly, stained deep brown with acidic tannins. The harsh conditions made human exploitation of the land difficult, hence the "barrens," and it was a magnet (or refuge) to the poor, desperate, and otherwise marginalized segments of society. Folks who live in the region are to this day sometimes called "pineys," a name once derogatory, but now more or less adopted as a badge of local pride. And of course, no thumbnail sketch of the region is complete without an aside to the Jersey Devil, which is a local variant of bigfoot, although strongly flavored with Christian occultism.

Before I dig into the book's substance, let's talk about its presentation. This is a quality softcover printed on good paper with clean typography. The many images (most in color) are of excellent



quality, albeit not printed glossy (which I think would have improved their value some). The book's layout is well done, and the writing is smooth and easy. In other words, the things that you should not notice, do not make themselves be noticed—and that is perfect.

This lovely little volume is focused on one slender topic...the *Drosera* of the Pine Barrens. There are only three species in this range—*Drosera rotundifolia*, *Drosera intermedia*, and *Drosera filiformis*—so the scope of the work isn't too large. In fact, you may wonder if you really need to buy this book, considering its narrow scope. Oh, yes, yes you do. The authors bring to this topic a special expertise earned from hours in the field, studying these plants in a variety of settings and times of the year. And it is so interesting to read their observations. These three species have somewhat overlapping, somewhat distinct preferred microhabitats, and a careful reading of this book will give you a great deal of valuable insight.

The authors also illustrate some lesser known characteristics of the individual species. Did you know about the deep-red-flower variant of *Drosera filiformis*? (I didn't!) They also add a great deal of information and insight as to the mysterious stem-forming expression of *Drosera intermedia*, which is so remarkable especially in New Jersey. And the authors also spend some valuable page spaces discussing the characters of *Drosera* in dormancy—a topic usually overlooked.

Equally as interesting as the species, are the hybrids. We know of two hybrids in the Barrens—*Drosera* × *hybrida* and *Drosera* × *eloisiana* (formerly, *D.* × *beleziana*). These are treated in detail, so you have an excellent exploration of what we know about them here in one place.

Simply said, if you have an interest in *Drosera*, you have an interest in this book. Buy it before it goes out of print!

If I felt this book had any deficits, it is that I would like to see the authors expand the work. And here is short list of things to add (perhaps, we might hope, in a second edition?):

- 1) Give us some understanding of why the Pine Barrens exist? What is the origin of its unique hydrology, geology, and ecology?
- 2) Perhaps some keys would be useful, especially for those who are trying to muddle out hybrids from pure species?
- 3) Finally, of course, how about throwing in the *Sarracenia* and *Utricularia* of the Barrens? Finish off the entire group of carnivores!

The authors of this book deserve a huge congratulations for their work, which—now it was completed—seems like it was surely long overdue!



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