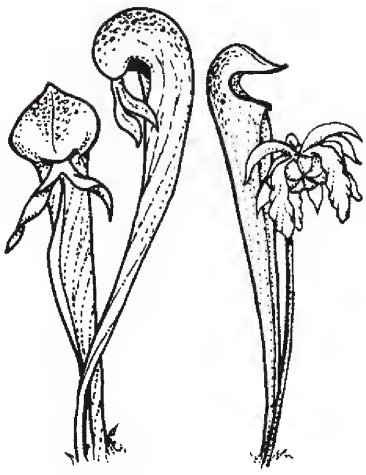
CARNIVOROUS PLANT NEWSLETTER

Journal of the International Carnivorous Plant Society

Volume 43, No. 2 June 2014



CARNIVOROUS PLANT NEWSLETTER

Journal of the International Carnivorous Plant Society
www.carnivorousplants.org

Volume 43, Number 2
June 2014

Front Cover: Juvenile pitchers in eight-month-old *Darlingtonia californica* seedlings. The image is a 22 photo composite by John Brittnacher. Article on page 40.

Back Cover: *Darlingtonia californica* seedling with an incompletely closed pitcher. This is the second true leaf. The first true leaf is the linear-lanceolate leaf under the newest forming pitcher. The image is a 29 photo composite by John Brittnacher. Article on page 40.

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.

All correspondence regarding dues, address changes and missing issues should be sent to the Membership Coordinator at the ICPS. Do not send such correspondence to the editors. Checks for subscriptions should be made to the ICPS in US funds. Dues for 2014 are $35 for the first year of membership; renewals are $30 per year.

International Carnivorous Plant Society, Inc.
2121 N. California Blvd., Suite 290
Walnut Creek, CA 94596-7351, USA
icps@carnivorousplants.org

President	Marcel van den Broek, marcel@carnivorousplants.org
Secretary/Treasurer	Richard Myers, richard@carnivorousplants.org
Board Member	Greg Bourke, Conservation Director, greg@carnivorousplants.org
Board Member	Richard Nunn, richardnunn@carnivorousplants.org
Board Member	Jan Schlauer, jan@carnivorousplants.org
Board Member	Bob Ziemer, bob@carnivorousplants.org
Administrator	Cindy Slezak, cindy@carnivorousplants.org
Seed Bank Manager	John Brittnacher, john@carnivorousplants.org
CPN Editors	editor@carnivorousplants.org
Managing Editor	Bob Ziemer
Editor	Barry Rice
Editor	Djoni Crawford
Science Editor	Fernando Rivadavia
Science Editor & Cultivar Registrar	Jan Schlauer

Date of effective publication of the March 2014 issue of Carnivorous Plant Newsletter: 12 March 2014.

The ICPS is the International Cultivar Registration Authority (ICRA) for the names of cultivated carnivorous plants according to the International Code of Nomenclature for Cultivated Plants. Send relevant correspondence to the ICPS, Inc.

Carnivorous Plant Newsletter is published quarterly in March, June, September, and December by the ICPS, Inc., 2121 N. California Blvd., Suite 290, Walnut Creek, CA 94596, USA. Periodicals postage paid at Richmond, CA and additional mailing offices. Postmaster: Send address changes to ICPS, Inc., 2121 N. California Blvd., Suite 290, Walnut Creek, CA 94596, USA. Printed by Allen Press, Inc., 810 E. 10th Street, Lawrence, KS 66044. Logo and masthead art: Paul Milauskas.
 ISSN #0190-9215

Contents

The non-carnivorous leaf of *Darlingtonia californica* ---- 40
Resolution of the *Drosera peltata* complex (Droseraceae) ---- 43
Status of insectivorous plants in northeast India ---- 49
Climate change is eliminating *Pinguicula macroceras* Link habitat in Montana ---- 59
International Carnivorous Plant Society 2012 Conference Field Trip ---- 61
An extended field trip in the USA ---- 67
Growing tuberous sundews ---- 71
New cultivars ---- 74

Call for Volunteers

With Mike Baldwin leaving the ICPS board and yours truly becoming president, I think this is a good time to call for reinforcements.

Mike leaves a vacancy on the board that needs to be filled and what we really would like to have is a new secretary. At this moment Richard Meyers, our treasurer, is doing this job also and that is a bit too many eggs in one basket. Ideally, this new treasurer should be inside the U.S., since ICPS is incorporated there and unfortunately several administrative tasks require someone to be physically in the U.S. — not to mention the fact that it is easier in many ways to be "in country".

The secretary/treasurer doubling that Richard is doing is also not the only egg-in-basket case. Most of the board members and active volunteers have little or no backup available, which is something we really would like to fix. So, if a full board position sounds like too much, but you are still willing to help, you might consider volunteering for backup duty. You can learn from the person doing the job right now, know how it works, and can help that person out when it gets a bit too busy or when something needs to be done when the principal is not available. A good backup (the more the better) is very welcome for any society and we are no exception.

In addition to backup for existing jobs, there are also things we could do but that are not being done due to lack of "person-power". For the last couple of months, Ben Rush has been doing a great job getting more activity and information exchange through social media. This was a very dormant activity before Ben arrived. There are many similar tasks that volunteers could pick up. Examples that come to mind are creating promotional materials, educational materials, and maybe even some specific conservation projects.

I think there are plenty of options. If you are willing to put some time in for your society, please contact us so we can have a talk. We have several suggestions or maybe you have some great ideas about things you want to do. After all, the best work is done by those with a passion to do the work.

For openers you could send an e-mail to me and we can take it from there.

Marcel van den Broek
President, ICPS
marcel@carnivorousplants.org

The non-carnivorous leaf of *Darlingtonia californica*

John Brittnacher • Ashland, Oregon • USA • john@carnivorousplants.org

Keywords: Physiology: *Darlingtonia californica* leaf structure.

It is well known that *Darlingtonia californica* has two types of carnivorous leaves (Goebel 1891; Lloyd 1942). The juvenile carnivorous leaves consist of a long tube with a narrow, tongue-like extension that quite often curves down toward if not to the ground (Front Cover). The adult carnivorous leaves are a hooded tube with a fish tail or mustache-like extension. Large juvenile leaves can also be found on stolons or underground runners from adult plants. Horizontal small adult leaves can be found on juvenile plants. Developmentally, the juvenile leaves are not just simplified adult leaves (Franck 1976). Each type of leaf is adapted to a different set of prey.

What is not well known is *Darlingtonia* makes a flat, linear-lanceolate leaf as the first true leaf after the cotyledons in seedlings. I believe this linear-lanceolate leaf is not carnivorous because there are no obvious glands. Lloyd (1942) and Franck (1976) saw this leaf in their plants but interpreted it as a third cotyledon. It is not a cotyledon (Fig. 1). The leaf emerges after the cotyledons and its base wraps the apex inside the ring of cotyledons. Goebel (1891) recognized this leaf for what it is and noted it is the only case he knew of where such a leaf is produced within the Sarraceniaceae. It is also the only case I know of. The first true leaf produced by *Sarracenia* seedlings and all *Heliamphora* I am aware of, is a pitcher. The phyllodia of *Sarracenia* are not analogous to this *Darlingtonia* leaf. *Sarracenia* phyllodia are pitcher-derived, unifacial leaves (both sides are technically the outer facing, abaxial side of the leaf). Phyllodia are not normally produced in juvenile *Sarracenia*.

At first glance it would appear bizarre that *Darlingtonia* would maintain the developmental program to produce this third type of leaf. However, if this is the ancestral leaf then it could be present because the developmental program to produce a pitcher initiates after the leaf forms. To test this, 541 seedlings were observed, checking for plants that deviated from the first true leaf being linear-lanceolate and the second true leaf a pitcher. The results are shown in Table 1 and images of aberrant plants are in Fig. 2, Back Cover, and Brittnacher (2014). Among the Del Norte County, California, seedlings, 1% had three cotyledons and 1% had a leaf configuration different from typical. The Siskiyou County, California, seedlings had 4% with three cotyledons and 5% with atypical leaf configurations. About 1% of seedlings started pitcher development earlier than typical either producing a pitcher as the first true leaf or producing a leaf intermediate between a linear-lanceolate leaf and

Table 1. Presence of leaf types in seedling *Darlingtonia californica*. The Del Norte Co. seeds were from 3 locations. The Siskiyou Co. seeds were from one location. All the locations were on mountains although the Del Norte Co. locations were about 600 m elevation while the Siskiyou Co. location was 2000 m elevation. The numbers are too small to determine statistical significance between the locations.

	Cotyledons		First true leaf			Second true leaf		
County	Two	Three	Linear	Interm.	Pitcher	Linear	Interm.	Pitcher
Del Norte	439	4	439	1	3	1	0	442
Siskiyou	94	4†	96	2†*	0	0	4*	94

† One plant had both 3-cotyledons and an intermediate first leaf

* One plant had both intermediate first and second leaves

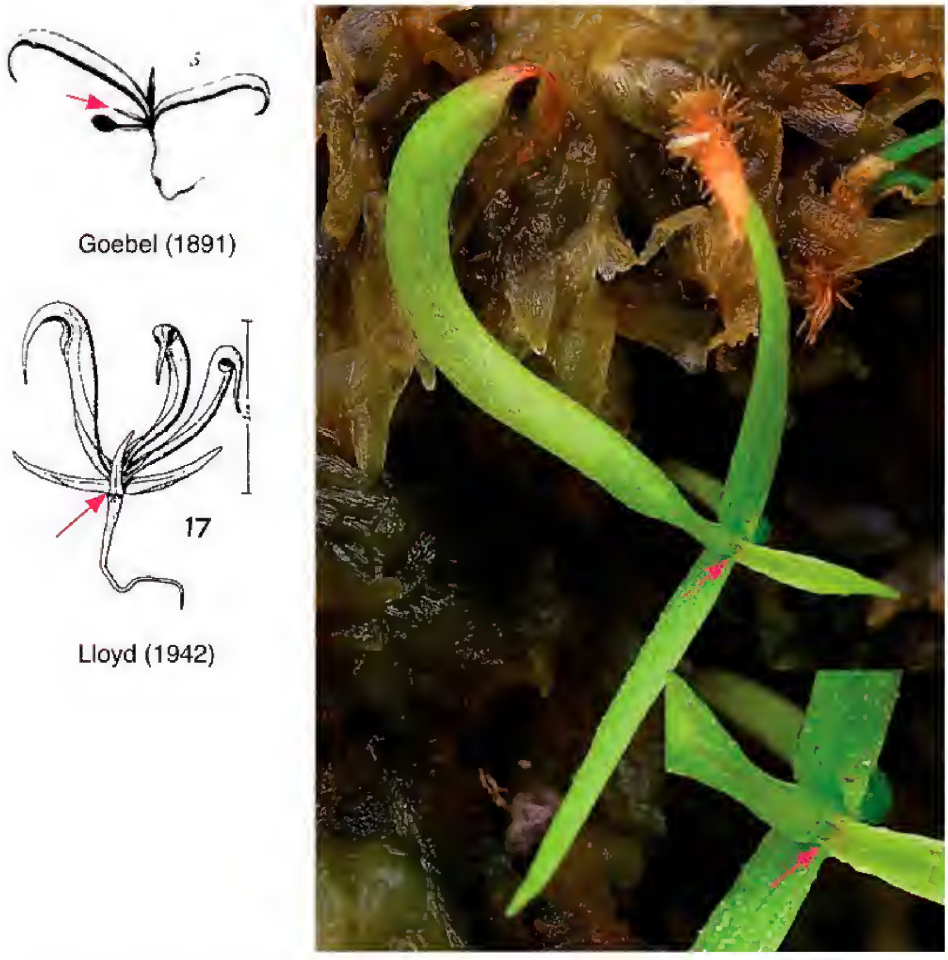


Figure 1: *Darlingtonia* seedlings. The drawing from Goebel (1891) shows the linear-lanceolate leaf shorter than the two cotyledons, one of which still has a seed attached. The Lloyd (1942) drawing shows the first true leaf as if it was a third cotyledon. The leaf should have been drawn enclosed by the cotyledons as shown by the image on the right. The inset details how the linear-lanceolate first true leaf wraps the apex within the cotyledons. Red arrows in photo indicate apex.

a pitcher. Another 1% started late, producing two linear-lanceolate leaves or an intermediate-type leaf as the second leaf. The exact numbers observed in this study are not necessarily indicative of the species as a whole since the seeds were collected from only a few individuals at each location.

As part of this study, I confirmed Harry Tryon's (personal communication) observation that the Mt. Eddy area, Siskiyou County seeds were larger with denser trichomes than seeds from coastal California, Oregon, and the Sierra Nevada of California (see Brittnacher 2014). It is not known if the differences in the seeds are the result of a unique difference in that population and whether a larger study would see differences in the seedlings.

The results of this study show the first true leaf in typical *Darlingtonia* seedlings appears to be an unmodified ancestral leaf. It is similar to the leaves of its relative *Roridula gorgonias* without the glandular hairs (see photos linked at http://cpphotofinder.com). The first true leaf not being a carnivorous leaf or derived from a carnivorous leaf in *Darlingtonia* appears to be unique among pitcher plants. *Sarracenia* and *Heliamphora*, sister genera to *Darlingtonia*, produce a juvenile pitcher as the first true leaf. Among non-relatives, the first true leaf in *Cephalotus* is a unifacial pitcher-derived

Figure 2: *Darlingtonia* seedlings with non-typical leaves: (a) three cotyledons instead of two, (b) second true leaf not a pitcher, (c) first true leaf a pitcher, (d) first true leaf intermediate between a linear-lanceolate leaf and a pitcher.

phyllode (see Brittnacher 2013) although a detailed study may show it can be either a pitcher or phyllode. Depending on the species or hybrid, the first true leaf of *Nepenthes* can range from recognizable adult-like pitchers to flattened leaf-like pitchers (see Brittnacher 2014).

Acknowledgement: I thank Mike Wang for seeds from two of the Del Norte Co. populations.

References

Brittnacher, J. 2013. Evolution -- the Oxalidales Carnivore. http://www.carnivorousplants.org/cp/EvolutionOxalidales.php, accessed 4 December 2013.

Brittnacher, J. 2014. Supplement to the non-carnivorous leaf of *Darlingtonia californica*. http://www.carnivorousplants.org/cpn/articles/CPNv43n2p40_42.supp.pdf.

Franck, D.H. 1976. Comparative morphology and early leaf histogenesis of adult and juvenile leaves of *Darlingtonia californica* and their bearing on the concept of heterophylly. Bot. Gaz. 137(1): 20-34.

Goebel, K. 1891. Pflanzenbiologische Schilderungen. Part 2, V. Insektivoren. Marburg.

Lloyd, F.E. 1942. The Carnivorous Plants. Chronica Botanica, Waltham, MA.

Resolution of the *Drosera peltata* complex (Droseraceae)

Robert Gibson • 5 Kristen Close • Cardiff Heights • NSW 2285 • Australia • robert.gibson@environment.nsw.gov.au
Barry Conn • National Herbarium of New South Wales • Sydney • NSW 2000 • Australia
Jeremy Bruhl • Botany, School of Environmental and Rural Science • University of New England • Armidale • NSW • Australia

Keywords: taxonomy, *Drosera peltata* complex.

Drosera peltata Thunb. was described from a specimen collection made in 1793 (Thunberg 7720) from the vicinity of current-day Sydney, Australia. In the years that followed at least a dozen morphologically similar taxa were described, often with imprecisely defined characters that led to confusion in the application of available names to plants in the wild and in cultivation. Conn (1981) and Gibson (1993) independently tackled part of this taxonomic problem and this led to one of us (R.G.) continuing the study of the complex as a PhD project at the University of New England. Additional morphological work resulted in the recognition of the *D. peltata* complex as comprising five species (Gibson *et al.* 2012). This paper is a summary of Gibson *et al.* (2012) and was prepared from Gibson's presentation at the 9th ICPS Conference.

Drosera peltata is a tuberous herb with an erect stem with alternate crescentic leaves that ends in a terminal raceme of flowers, and may have a basal rosette formed prior to stem growth. This habit was recognized in several subsequently-described sundews, notably *D. auriculata* Backh. ex Planch., *D. foliosa* Hook.f. ex Planch., *D. gracilis* Hook.f. ex Planch., *D. insolita* Taton, *D. lobbiana* Turcz., *D. lunata* Buch.-Ham. ex DC., *D. nipponica* Masam., and *D. peltata* "Western Australian Form" (Lowrie 1987). These taxa differ from *D. peltata* by such characters as the presence or absence of hairs on the sepal margin and exterior sepal surface, seed size and shape, geographic range, bracteole morphology, and the presence of a basal rosette and whether, if present, it persists to the time of flowering (Clarke 1879; Turczaninow 1854).

Measurements of 294 morphological features from 213 plants of the *D. peltata* complex were made. Where available, measurements were taken from type collections in order to clarify taxon concepts and to assist in the application of available names. Of the features measured, 198 were qualitative characters. Data was subsequently analyzed using cluster analysis and ordination techniques (Sneath & Sokal 1973). Despite the promising results of a pilot study, the analysis of a fuller data set had poor resolution and led to the conclusion that the *D. peltata* complex comprised a single, widespread and variable species. This result was at odds with observations of clearly distinct members of this complex that remained distinct in the field, particularly where sympatric, and in cultivation.

Further analysis of the dataset suggested that its high noise to signal ratio was due to missing values (due to a missed growth stage, such as no basal rosette formed; or the plant was picked before seed maturity; or the way the specimen was subsequently pressed) and from the measurement of variable or shared characters that could not define distinct taxa. During this time the important question of "do you really need to measure 294 characters in order to identify a member of this complex?" was posed. As a consequence, a new dataset of 29 characters from 89 Operational Taxonomic Units (OTUs) was compiled that was derived from the most complete specimens from the PhD dataset to which new specimens were added. Cluster and ordination analyses on this new dataset provided support for the recognition of five species within the *D. peltata* complex: *D. auriculata*,

D. hookeri, *D. lunata*, *D. peltata*, and *D. peltata* "Western Australian Form" (now *D. yilgarnensis* R.P.Gibson & B.J.Conn). These five taxa were also supported by preliminary analysis of molecular data and the different ecological niches (which occasionally overlap) and geographic ranges that they occupy (Gibson *et al.* 2012).

Once the final taxa had been identified, this led to the quest to assign appropriate type specimens. For *D. hookeri* (Gibson *et al.* 2010) and *D. peltata* (Conn 1981), this work had been done before. In the case of *D. auriculata*, the type collection had been identified in the original description (Planchon 1848). This collection is housed at the herbarium of the Royal Botanic Gardens in Kew, England, and contains three other collections (all of which are *D. peltata*). Thus we assigned one plant with as many characters as possible (*i.e.* basal rosette, cauline leaves, and inflorescence) in the type collection as the lectotype for this taxon; the other plants in that collection became isolectotypes. Assigning a lectotype to *D. lunata* was relatively straightforward once the name for this taxon had been resolved. This widespread member of the group had been described multiple times in the last 200 years. However, de Candolle's (1824) circumscription had priority. Therefore a specimen with most of the characters of this taxon, from a collection cited by de Candolle, was designated as the lectotype.

The five species recognized are briefly described below. Specific rank was chosen to be consistent with the combinations of co-varying characters used to define other species in *Drosera* subgenus *Ergaleium* (*e.g.* Marchant *et al.* 1982).

Drosera auriculata Backh. ex Planch.

The "Tall Sundew" (*D. auriculata*) is found in seasonally moist soils in south eastern Australia and the northern half of New Zealand (Salmon 2001). This species is distinguished by its glabrous sepals, with an entire to irregularly serrulate margin, and its cylindrical seeds that are usually 0.8 to 1.6 mm long. Plants of *D. hookeri* with glabrous sepals from inland parts of south eastern Australia have frequently been misidentified as *D. auriculata*.

Drosera hookeri R.P.Gibson, B.J.Conn & Conran

Much confusion has surrounded the appropriate name(s) to apply to yellow-green plants with deeply-pitted seeds of the *D. peltata* complex in south eastern Australia and the far north of New Zealand. In Tasmania, Victoria, and South Australia in particular short, multi-stemmed plants with white-petalled flowers with densely hairy sepals (formerly "*D. foliosa*") often grow with or near tall, sparsely branched plants with white or pink-petalled flowers with variably hairy (occasionally glabrous) sepals where they form seemingly stable populations that remain distinct. Plants in our study grouped according to plant stature and the degree of sepal hairiness, but in a way that only allowed for the application for one name at species level, to which *D. hookeri* has priority thereby broadening the scope of the application of this name (Gibson *et al.* 2010). Furthermore, unpublished data on molecular sequences and the percentage of seed set from experimental pollinations of members of the *D. peltata* complex does not support the recognition of different growth forms of *D. hookeri* at specific level.

Drosera lunata Buch.-Ham. ex DC.

Drosera lunata has been reinstated as a species after being sunk to synonymy of *D. peltata* by Diels (1906). Plants are characterized by their (typically) glabrous sepals and small ovoid seeds. This species is now recognized as the most widespread of the tuberous species of *Drosera* and occurs across South East Asia, southern India, the Himalayas, southern China,

South Korea, and southern Japan in addition to northern and eastern Australia. Plants grow in seasonally moist soils and often grow in the hotter (and wetter) months of the year contrary to the usual cool-seasonal growth of most tuberous *Drosera*. In Australia, *D. lunata* has been frequently misidentified as *D. auriculata* on the basis of its glabrous sepals. However, these species differ in seed size and shape and typical flowering season (*D. auriculata*: winter and spring; *vs*. *D. lunata*: summer and autumn) which will enable both species to be differentiated where their ranges overlap between Sydney and the Border Ranges of south eastern Queensland. To complicate matters, a few populations of *D. lunata* from Japan have scattered hairs on their outer sepal surfaces (Mr. Koji Kondo, pers. comm., 2012), but all other characters are typical of this species.

Drosera insolita Taton has been an enigmatic species since it was first described in 1945. It was described from a single herbarium collection of a single plant reportedly collected in central Africa; making it the first and only record of a tuberous *Drosera* from that continent. The plant has few (3 or 4)-flowered inflorescences with bracteoles with dentate margins and was said to rarely produce secondary growth in its leaf axils. After considering all of these factors this taxon was given specific rank (Taton 1945). However, the geographical location written on the voucher was incorrect, and that it had instead been collected from southern China (where *D. lunata* occurs widely) (Dr. Elmar Robbrect, pers. comm., 2002). The bracteoles of plants of *D. lunata* vary greatly in size and shape, and include bracteoles with dentate margins (Yun-Zhen 1981: Fig. 2). Examination of the *D. insolita* specimen revealed that the primary stem had been removed just above its base and the plant had six secondary stems each of which terminated in an inflorescence; thus this specimen in fact had abundant secondary growth. Axillary stems of plants in the *D. peltata* complex produce fewer-flowered racemes than that atop the primary stem. Therefore, when all of these factors were considered *D. insolita* was reduced to synonymy with *D. lunata*.

Drosera peltata Thunb.

The type collection of *Drosera peltata* comprises a single plant (Thunberg 7720) collected when just starting to flower. The pressed partially open flower does not present any styles, and no seed characters are available. However, based on the hairy sepal surface and margin, and the size of the sepals and leaves, the specimen was matched with plants that had informally been called "*D. peltata* 'Red Rosette/White petal form'" (Gibson 1993) thereby resolving a long-standing botanical mystery. From our studies all red-rosetted OTUs grouped together and as a consequence "*D. gracilis*" from Tasmania and the highlands of the south eastern Australian mainland was sunk to synonymy with *D. peltata*. This species inhabits permanent rather than seasonal wetlands. Morphologically similar plants occur along the mountainous spine of the island of New Guinea, however no voucher specimens with pressed open flowers or ripe seed were found to include in the analysis to test if they also belong to this species.

Drosera yilgarnensis R.P.Gibson & B.J.Conn

What was previously referred to as "*D. peltata* 'Western Australian Form'" (Lowrie 1987) has been recognized as a distinct species by our study and described as *D. yilgarnensis*; the specific epithet is based the strong association that this species has with granite outcrops in south western Australia, and that these outcrops are part of the "Yilgarn Craton" that forms most of the bedrock of this part of the country. Unlike other members of the *D. peltata* complex this species always forms basal rosettes and is also characterized by flowers with glandular hairy sepals and between 30 and 60 style segments (Fig. 1).

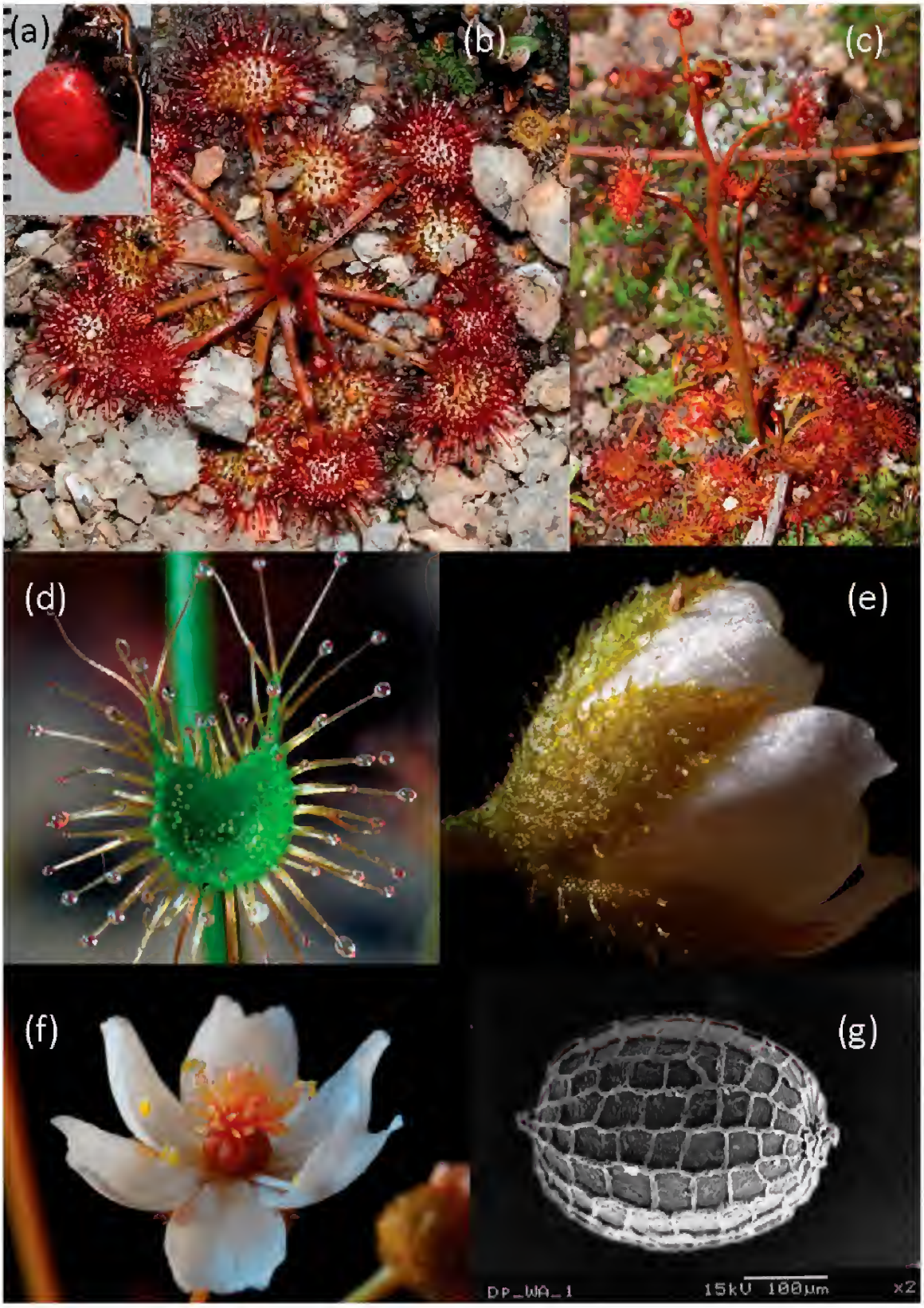


Figure 1: Photomosaic of *Drosera yilgarnensis*. (a) tuber; (b) well-developed basal rosette and developing stem; (c) plant with a rapidly growing stem with developing terminal racemes; (d) cauline leaf; (e) glandular hairy sepals on an opening flower; (f) open flower showing the multidivided styles; and (g) SEM of a ripe seed from P. Mann 18/2003 & R. Gibson (NSW). Photos (a) to (f) by R. Gibson; photo (g) by P. Littlefield.

The apparent mismatch of existing classifications to members of the *D. peltata* complex ultimately led to the collection of additional vouchers of the complex from across its range from which morphological data was collected and subsequently analyzed. Initial results were discouraging due to the inclusion of measurements from characters with poor fidelity to taxon limits and missing values in the dataset. Whilst morphological analysis is by its very nature an iterative process it is still possible to make an educated guess on the main characters to target and the literature provides studies that can help to get you started, *e.g. Drosera indica* complex (Susandarini *et al*. 2002); and *Sarracenia* species (Schnell & Krider 1976).

The main lessons learnt from this project are: (1) regular on-going data analysis during the data-collection stage helps avoid last-minute surprises in a project; (2) data quality is more important than data quantity; and (3) persistence does pay off. The most useful characters we found to distinguish between the five different species of the *D. peltata* complex are: (1) the nature of the sepal margin; (2) the degree of division of the styles; (3) seed size and shape; and (4) seed surface texture. Further study on the different forms of *D. hookeri* appears warranted to test whether it is appropriate to formally recognize any of them and, if so, at what taxonomic rank. In conclusion, morphological analysis is a useful tool for testing taxon concepts and limits and so far appears to be underutilized in its application to the taxonomy of carnivorous plants.

Acknowledgements: We thank the directors and staff of following herbaria for access to the collections in their care: BM, BRI, BR, HO, K, NE, and NSW. R.G. thanks Dr. Elmar Robbrect at BR for sharing information on *D. insolita* and to Mr. Koji Kondo for information of *D. lunata* in Japan. Thanks also to Mr. Patrick Littlefield (UNE) for his assistance in producing the SEM image used in this paper. The authors gratefully acknowledge funding from a Noel C. W. Beadle Scholarship (UNE) that helped fund the use of the SEM microscope.

References

Candolle, A.P. de. 1824. Droseraceae. In: A.P. de Candolle (ed.). Prodromus systematis naturalis regni vegetabilis. Treuttel and Wutz, Paris. pp. 317-320.

Clarke, C.B. 1879. Droseraceae. In: J.D. Hooker (ed.). The Flora of British India. L. Reeve & Co., London. pp. 423-425.

Conn, B.J. 1981. The *Drosera peltata-D. auriculata* complex. Journal of the Adelaide Botanic Gardens 3: 91-100.

Diels, L. 1906. Droseraceae. In: A. Engler (ed.). Das Pflanzenreich: regni vegetabilis conspectus. Engelmann, Leipzig, Germany. pp. 1-137.

Gibson, R. 1993. A closer look at *Drosera peltata* and *D. auriculata* in western Sydney. Bulletin of the Australian Carnivorous Plant Society 12: 11-17.

Gibson, R., Conn, B.J., and Bruhl, J.J. 2012. Morphological evaluation of the *Drosera peltata* complex (Droseraceae). Australian Systematic Botany 25: 49-80.

Gibson, R., Conn, B.J., and Conran, J.G. 2010. *Drosera hookeri* R.P.Gibson, B.J.Conn & Conran, a replacement name for *D. foliosa* Hook.f. ex Planch. *Nom illeg.* (Droseraceae). Journal of the Adelaide Botanic Gardens 24: 39-42.

Lowrie, A. 1987. Carnivorous Plants of Australia: Vol. 1. University of Western Australia Press, Nedlands.

Marchant, N.G., Aston, H.I., and George, A.S. 1982. Droseraceae. In: A.S. George (ed.). Flora of Australia. Vol. 8. Australian Government Publishing Service, Canberra. pp. 9-64, 77, 383-385.

Salmon, B. 2001. Carnivorous Plants of New Zealand. Ecosphere Publications, Auckland.

Schnell, D.E., and Krider, D.W. 1976. Cluster analysis of the genus *Sarracenia* L. in Southeastern United States. Castanea 41: 165-176.

Sneath, P.H.A., and Sokal, R.R. 1973. Numerical Taxonomy: The Principles and Practice of Numerical Classification. Freeman, San Francisco.

Susandarini, R., Collins, G.G., Lowrie, A., and Conran, J.G. 2002. Morphological variation within the *Drosera indica* (Droseraceae) complex in northern Australia. Australian Journal of Botany 50: 207-214.

Taton, A. 1945. Nouveau *Drosera* du Congo Belge. Bulletin du Jardin Botanique de l'État à Bruxelles 17: 301-311.

Turczaninow, N. 1854. Animadversiones ad primam partem herbarii Turczaninowiani, nune universitatis caesereae charkowiensis. Bulletin de la Societe des Naturalistes de Moscou 27: 271-372.

Yun-Zhen, R. 1981. On the Chinese species of *Drosera* L. Acta Phytotaxonomica Sinica 8: 339-344.

Status of insectivorous plants in northeast India

Praveen Kumar Verma • Shifting Cultivation Division • Rain Forest Research Institute • Sotai Ali • Deovan • Post Box # 136 • Jorhat 785 001 (Assam) • India • pkverma_bryo@yahoo.co.in
Jan Schlauer • Zwischenstr. 11 • 60594 Frankfurt/Main • Germany • jan@carnivorousplants.org
Krishna Kumar Rawat • CSIR-National Botanical Research Institute • Rana Pratap Marg • Lucknow -226 001 (U.P) • India
Krishna Giri • Shifting Cultivation Division • Rain Forest Research Institute • Sotai Ali • Deovan • Post Box #136 • Jorhat 785 001 (Assam) • India

Keywords: Biogeography, India, diversity, Red List data.

Introduction

There are approximately 700 identified species of carnivorous plants placed in 15 genera of nine families of dicotyledonous plants (Albert *et al.* 1992; Ellison & Gotellli 2001; Fleischmann 2012; Rice 2006) (Table 1).

In India, a total of five genera of carnivorous plants are reported with 44 species; *viz*. *Utricularia* (38 species), *Drosera* (3), *Nepenthes* (1), *Pinguicula* (1), and *Aldrovanda* (1) (Santapau & Henry 1976; Anonymous 1988; Singh & Sanjappa 2011; Zaman *et al*. 2011; Kamble *et al*. 2012). Interestingly, northeastern India is the home of all five insectivorous genera, namely *Nepenthes* (commonly known as tropical pitcher plant), *Drosera* (sundew), *Utricularia* (bladderwort), *Aldrovanda* (waterwheel plant), and *Pinguicula* (butterwort) with a total of 21 species. The area also hosts the "ancestral false carnivorous" plant *Plumbago zelayanica*, often known as murderous plant.

Climate

Lowland to mid-altitude areas are characterized by subtropical climate (Table 2) with maximum temperatures and maximum precipitation (monsoon) in summer, *i.e.*, May to September (in some places the highest temperatures are reached already in April), and average temperatures usually not dropping below 0°C in winter. As usual average temperatures decrease with increasing elevation, and in highlands, a mountain/alpine climate prevails. In Sikkim and Arunachal Pradesh, the tree line ranges from 5500 m in the north to 4000 m in the south, and the snow line ranges from 6100 m in the north to 4900 m in the south.

Chorology

The extreme northeast of India (Sikkim, Darjeeling – the northern part of West Bengal, Arunachal Pradesh, Assam, Meghalaya, Nagaland, Manipur, Tripura, Mizoram) is one of the most floristically most diverse places in Asia as it is located in the contact zone between the temperate flora from high elevations (Himalaya), the tropical flora from lowland peninsular India and Burma, and the subtropical flora from Yunnan, China. To the west it shares a border with Nepal, to the north with Bhutan, and China (Tibet), to the east with Burma (Myanmar) and to the south with Bangladesh. Covering less than 275,000 km^2, it is composed of six different floristic provinces in four

Table 1. Comparison of carnivorous plant diversity (world/India/NE India). Data derived from the Carnivorous Plant Database. http://www.omnisterra.com/bot/cp_home.cgi, accessed 24 Feb. 2014.

Order	Family	Genus	Number of described species		
			World	India	NE India
Oxalidales	Cephalotaceae	*Cephalotus*	1		
Nepenthales (Caryophyllales s. lat.)	Droseraceae	*Drosera*	168	3	2
		Aldrovanda	1	1	1
		Dionaea	1		
	Drosophyllaceae	*Drosophyllum*	1		
	Nepenthaceae	*Nepenthes*	127	1	1
	Dioncophyllaceae	*Triphyophyllum*	1		
Ericales	Sarraceniaceae	*Darlingtonia*	1		
		Heliamphora	20		
		Sarracenia	8		
	Roridulaceae	*Roridula*	2		
Scrophulariales (Lamiales)	Byblidaceae	*Byblis*	7		
	Lentibulariaceae	*Pinguicula*	94	1	1
		Genlisea	27		
		Utricularia	234	38	16
Total			693	44	21

Regions according to Takhtajan's (1986) scheme: the Northern Burmese, Eastern Himalayan, and Khasi-Maipur Provinces belonging to the Eastern Asiatic Region, the Tibetan Province belonging to the Irano-Turanian Region, the Bengal Province belonging to the Indian Region, and the Southern Burmese Province belonging to the Indochinese Region. Any area of comparable size and latitudinal extension (between 22°N and 30°N) in the New World or in Africa would cover at the most three Provinces in at the most two Regions. This extraordinary diversity is mainly due to the unique topographical profile, ranging from almost sea level in the Brahmaputra valley to 8598 m elevation (Kangchenjunga) at the Nepal border.

Pinguicula alpina (arctic + alpine + Himalayan) belongs to the temperate element. The paleotropical element is represented by *Nepenthes khasiana*. Its entire range is contained in the area of concern and is located north of the Tropic of Cancer, *i.e.*, this is the only species in the genus *Nepenthes* naturally occurring outside the tropics. *Drosera peltata* is widespread in eastern Asia, Australia, and Oceania (Gibson *et al.* 2012, as *D. lunata*). It is the only tuber forming sundew to reach beyond the Australian diversification center of this group. *Drosera burmannii* is widespread in the Australasian tropics. While it is disputed whether its only record from Africa (Sierra Leone) is native there, another, closely related species (*D. sessilifolia*) is its neotropical counterpart. The tropical bladderworts in the area are the terrestrial *Utricularia hirta*, *U. pubescens*, *U. caerulea*, *U. bifida*, *U. recta* (syn. *U. scandens* subsp. *firmula*), *U. foveolata*, *U. subulata*, and the aquatic *U. aurea*, *U. stellaris*, and *U. inflexa*, all of which are more or less widespread in tropical eastern Asia

Table 2. Climate data of representative towns in NE India (classification according to Köppen & Geiger 1930-1939, data from Wikipedia http://en.wikipedia.org/).

Location; State; Elevation	Climate Class	Precipitation	Temperature
		Annual /Monthly	Summer / Winter
Aizawl; Mizoram; 1132 m	Humid Subtropical (Cwa)	2200 mm / 6 mm (Jan.) - 305 mm (Aug.)	18-27°C (max.: Apr.) / 25-11°C
Agartala; Tripura; 13 m		2200 mm / 8 mm (Dec.) - 455 mm (Jun.)	24- 34°C (max.: Apr.) / 33-10°C
Guwahati; Assam; 55 m		1700 mm / 7 mm (Dec.) - 345 mm (Jul.)	22-32°C / 30-10°C
Imphal; Manipur; 790 m		1400 mm / 12 mm (Jan.) - 225 mm (Jun.)	15-33°C / 30-11°C
Kohima; Nagaland; 1450 m		1800 mm / 8 mm (Dec.) - 370 mm (Jul.)	17-25°C / 23-5°C
Shillong; Meghalaya; 1500 m	Subtropical-Highland (Cwb)	2200 mm / 9 mm (Dec.) - 470 mm (Jun.)	15-24°C / 23-4°C
Itanagar; Arunachal Pradesh; 750 m		2300 mm / 15 mm (Nov.) - 510 mm (Jul.)	18-34°C / 18-8°C
Darjeeling; N West Bengal; 2050 m		3000 mm / 7 mm (Dec.) - 780 mm (Jul.)	11-20°C / 14-2°C
Gangtok; Sikkim; 1700 m		3600 mm / 23 mm (Dec.) - 650 mm (Jul.)	13-22°C / 18-4°C

and many spread to tropical Africa and Australia, while only *U. pubescens* and *U. subulata* are also found in the Americas.

Utricularia. gibba and *Aldrovanda vesiculosa* represent azonal aquatics not closely tied to any climatic vegetation zone.

An exceptionally large number of species of the subtropical to tropical section *Phyllaria* of *Utricularia* (*U. furcellata*, *U. christopheri*, *U. brachiata*, *U. striatula*, *U. multicaulis*) are native or even endemic to this area. *Utricularia kumaonensis*, *U. salwinensis*, and *U. forrestii*, likewise members of this section, are known from the Salween-Irrawaddy divide in westernmost Yunnan, China/northernmost Burma, *i.e.*, within some 200 km to the east of the area treated here. As all three species do also occur in the immediate vicinity to the north (Nepal, Bhutan, Tibet), it is quite probable that they occur in Himalayan northeastern India although no specimens have apparently been collected from here so far.

Other species presently not recorded from the area but known from surrounding territories are:
Drosera indica (paleotropical, including. West Bengal, *cf.* Basak 1975, China [Yunnan], Burma);
Utricularia capillacea (syn. *U. scandens*, paleotropical, including. Bihar, Nepal, China [Tibet, Yunnan], Burma, Bangladesh);
U. graminifolia (tropical East Asian, including, China [Yunnan], Burma);
U. uliginosa (tropical East Asian, including, China [Yunnan], Burma);
U. australis (azonal, widespread in the Old World, including, Nepal, Bhutan, China [Tibet, Yunnan], Burma);
U. minor (circumboreal, including, Nepal, Bhutan, China [Tibet, Yunnan], Burma).

The majority (some 20) of the remaining Indian bladderwort species not known from the extreme northeast are members of *U.* section *Oligocista* and are more or less restricted to the Deccan peninsula, predominantly in the Western Ghats (Janarthanam & Henry 1992; Taylor 1989).

Conservation Status

1. *Nepenthes khasiana* Hook. f.: Popularly known as tropical pitcher plants or monkey cups, *Nepenthes khasiana* belongs to the monotypic family Nepenthaceae with 127 natural and hybrid species across the world (Jebb & Cheek 1997; Wikipedia 2013). It is the only native Indian species of insectivorous plant which is an endemic of Garo, Khasi, and Jaintia hills of Meghalaya. It greatly varies in its habit ranging from prostrate to scandent or rarely erect herbs, undershrubs, or shrubs. The plants are mostly associated with the natural vegetation of very humid climates.
Distribution in northeast India: Endemic to Meghalaya**:** East Khasi hills, West Khasi hills, Jaintia hills, south Garo hills, west Garo hills (Joseph & Joseph 1986; Venugopal & Devi 2003; Singh *et al.* 2011).
Present status: Habitat destruction is one of the main threats especially in Jaintia and Garo hills, where the coal mining plays a significance role in the decline of its natural population (Prasad & Jeeva 2009; Singh *et al.* 2011). Excessive collection, developmental activities, deforestation, fragmentation, increasing production of waste and pollutants, forest fire, *jhum* cultivation, and poor seed germination ability of the plant are also some of the causes of declining populations (Bordoloi 1977; Jain & Sastry 1980; Rathore *et al.* 1991; Mandal & Mukherjee 2011). It is classified as 'Endangered' (EN) and is incorporated in the Appendix I of CITES and Negative List of Exports of the Government of India (Ziemer 2010; Mandal & Mukherjee 2011). The species is restricted only in some pockets of Meghalaya.

2. *Drosera* L.: One of the largest genera of carnivorous plants (commonly known as sundews) with more than 160 species belonging to the family Droseraceae (Rice 2006; Jayaram & Prasad 2006).

2.1. *Drosera burmannii* Vahl: One of the most common insectivorous species among Indian carnivorous plants and found in tropical and subtropical parts of the country. This annual species possess spatulate leaves and forms rosettes which spans up to 2.5 cm. This species has important medicinal properties as it contains several medicinally active compounds including quinones (plumbagin), hydroplumbagin glucoside, flavonoids (kaempferol, myricetin, quercetin, and hyperoside), rossoliside (7-methyl-hydrojuglone-4-glucoside), and has been used for several disorders (Raju & Christina 2013).
Distribution: Arunachal Pradesh, Assam, Meghalaya, Sikkim, Tripura (Majumdar *et al.* 2011).
Present status: Least concerned (LC) ver.3.1, IUCN, 2011 (Zhuang 2011a). The species has a wide range of distribution and no current threats are reported for Indian populations.

2.2 *Drosera peltata* Thunb. (syn. *Drosera lunata* Buch.-Ham. ex DC.)**:** This is a climbing or scrambling sundew species commonly called shield sundew. The species possesses cauline or peltate cauline leaves and can be easily identified in the field with its aerial parts growing from 5 to 15 cm in height. The species is a promising medicinal plant species due to its antimicrobial activity particularly against the oral bacteria (Didry *et al.* 1998).
Distribution in northeast India: Meghalaya (Jantia hills, east and west Khasi hills), (Venugopal *et al.* 2007).

Present status: The species is somewhat rare and known only in some areas of Meghalaya growing on expose rocks in association with mosses.

3. *Utricularia* L.: Another large genus of carnivorous plants with more than 230 species, which belongs to the family Lentibulariaceae (Parnell 2005; Fleischmann 2012) and commonly grows in floating as well as marshy lands. Unlike the other carnivorous plants discussed here, *Utricularia* often lives in aquatic conditions. A total of 16 species are found in northeastern India.

3.1. *Utricularia aurea* Lour.: Commonly known as golden bladderwort and is common in marshy and wet land of the area. Another important plant with compounds showing anti-tumor activity have been reported (Choosawad *et al*. 2005).
Distribution in northeast India: Assam (Sharma 2012, as *Utricularia flexuosa* Vahl.), Tripura (Bhowmik & Datta 2013).
Present status: The IUCN, 2103 listed the species under Least Concern (LC) ver 3.1 (IUCN 2013).

3.2. *Utricularia bifida* L.: The small and annual plants are found growing in marshy land as well as damp soil and commonly known as bifid bladderwort.
Distribution in northeast India: Assam, Meghalaya, Tripura (Bhowmik & Datta 2012a, 2013).
Present status: No major threats has been reported regionally as well as globally hence it been identified and is therefore listed as Least Concern (LC) 3.1. (Zhuang 2011b).

3.3. *Utricularia brachiata* Oliv.: Discovered by J.D. Hooker from Sikkim Himalaya and partially described by D. Oliver in 1859. The plants are very small, inconspicuous, with delicate, reniform leaves and grow as epiphyte intermixed with bryophytes on tree trunks (Compton 1909).
Distribution in northeast India: Arunachal Pradesh, Sikkim- Kyongnosla Alpine Sanctuary (Compton 1909; Taylor 1989).
Present status: In northeast India the species is very rare and restricted only to the upper hills of eastern Himalaya with in rather small populations.

3.4. *Utricularia caerulea* L.: Small to medium sized species commonly known as blue bladderwort (Kato *et al*. 2006; Kamble *et al*. 2012).
Distribution in northeast India: Meghalaya, Tripura (Bhowmik & Datta 2012b).
Present status: Very common in distribution and found from Madagascar to Japan and Australia through India and Malaysia (Kamble *et al*. 2012).

3.5. *Utricularia christopheri* P.Taylor: Perennial in nature.
Distribution in northeast India: Confined to East Himalayan region including Nepal; Sikkim-Changu, Lachen (Taylor 1989).
Present status: Grows in very high elevation in Sikkim Himalaya and Nepal with very limited distribution (Taylor 1989).

3.6. *Utricularia gibba* L.: A perennial aquatic herb commonly known as humped bladderwort. May be floating, growing submerged, or exposed on wet soil. One of the most common species among *Utricularia* (Taylor 1989).
Distribution in northeast India: Meghalaya (as *U. khasiana* Joseph & Mani), Tripura (as *U. gibba* subsp. *exoleta* (R. Br.) P.Taylor) (Deb 1983; Bhowmik & Datta 2013), Assam and Manipur (as *U.*

exoleta R. Br.) (Dixit & Bera 2012; Hazarika & Borthakur 2012).
Present status: Least Concern (LC) ver 3.1 (Anitha 2011).

3.7. *Utricularia foveolata* Edgew.: A small short-lived herb growing in shallow water or wet soil in seasonally wet grassland or occasionally as a weed in ricefields.
Distribution in northeast India: Meghalaya: Elephant Falls as *U. baouleensis* A. Chev. (Subramanyam & Kamble 1968).
Present status: Very rare in occurrence as it has been reported only once from Elephant Falls of Meghalaya in 1968 and no further reports are available from this area. Hence more detailed surveys are necessary to reveal its current status in India.

3.8. *Utricularia furcellata* Oliv.: Grows on moist logs or rocks along with mosses and form 3-5 mm wide rosettes.
Distribution in northeast India: Assam, Meghalaya, Mizoram, West Bengal (Suksathan & Parnell 2010; Chew & Haron 2011; Panday *et al.* 2013; Yee *et al.* 2012).
Present status: The status is yet to be worked out; however, recently it has been considered as rare in Mizoram (Panday *et al.* 2013).

3.9. *Utricularia hirta* J.G.Klein ex Link.: A small perennial, terrestrial insectivorous plant, native of Southeast Asia, and always growing in damp open places.
Distribution in northeast India: Meghalaya (Joseph & Mani 1982, as *U. tayloriana* J.Joseph & J.Mani), Tripura (Joseph & Mani 1982; Natarajan *et al.* 2008).
Present status: Least Concern (LC) ver 3.1 (Anitha 2011).

3.10. *Utricularia multicaulis* Oliv.: Very small growing annually and native of Southeast Asia.
Distribution in northeast India: Sikkim (Oliver 1859).
Present status: Discovered from Sikkim by Oliver (1859). Though the species has also been reported from China, in India, the plants seem extremely rare, as further reports are scanty.

3.11. *Utricularia striatula* Sm.: Commonly known as striped bladderwort is a small insectivorous herb which is growing on wet rock or even on tree trunks.
Distribution in northeast India: Meghalaya, Nagaland, Sikkim (Lal *et al.* 2003; Lansdown *et al.* 2013).
Present status: Least Concern (LC) ver 3.1.

3.12. *Utricularia pubescens* Sm.: A small to medium sized herbaceous annual plant growing on soil as well as on wet rocks.
Distribution in northeast India: Meghalaya (Rao & Joseph 1967).
Present status: Reported only once from the area (*v.s.*). Seems to be rare, as it is known from only one more locality in India, *i.e.* Rajpur, near Dehradun (Saxena 1965).

3.13. *Utricularia recta* P. Taylor (*U. scandens* subsp. *firmula* (Oliver) Z. Yu Li)**:** Small herb, growing in grassland as well as on rocks.
Distribution in northeast India: NE India (Li & Cheek 2011).
Present status: Widespread in Africa and Asia**.** In India in the Himalayan part of Uttarakhand (Kumaun), in Sikkim and in Meghalaya (Khasi Hills), and widespread in Nepal and Bhutan; in China only known from western Yunnan (Taylor 1989).

3.14. *Utricularia subulata* L.: An annual to perennial terrestrial plant.
Distribution in northeast India: Jarain, Meghalaya (Joseph & Mani 1982, misidentified as *U. stanfieldii*, an African species that is not known from India, *cf.* Taylor 1989).
Present status: Widespread and common in India.

3.15. *Utricularia inflexa* Forssk.: Medium to large sized suspended aquatic with a whorl of 5-10 floats near the base of the peduncle, corolla white with violet nerves.
Distribution in northeast India: Assam (Taylor 1989).
Present status: Widespread throughout India.

3.16. *Utricularia stellaris* L. f.: Medium to large sized suspended aquatic with a whorl of 3-8 floats above the middle of the peduncle, corolla yellow.
Distribution in northeast India: Meghalaya (Joseph & Joseph 1986; Taylor 1989).
Present status: Widespread.

4. *Pinguicula alpina* L. (Lentibulariaceae): Also known as alpine butterwort, it is a small, herbaceous, perennial insectivore and has white personate spurred flowers, some with a yellow palate.
Distribution in northeast India: Sikkim (Singh & Sanjappa 2011).
Present status: Widespread in alpine region of the Himalaya.

5. *Aldrovanda vesiculosa* L. (Droseraceae): A rare, monotypic, rootless, free floating aquatic carnivorous plant (floats just below the water surface).
Distribution in northeast India: Manipur- Imphal (Zaman *et al.* 2011).
Present status: Very rare in northeastern India and only once reported from Imphal by Deb in 1965 (Zaman *et al.* 2011) and since then it never have been collected there nor from other parts of India. The IUCN (IUCN 2013) listed the species as Endangered B2ab (iii, v) ver 3.1 (Cross 2012).

Acknowledgements: We are thankful to the Director of the Rain Forest Research Institute, Jorhat, Assam, for his encouragement. JS expresses his sincere thanks to Andreas Fleischmann for improving the manuscript.

References

Albert, V.A., Williams, S.E., and Chase, M.W. 1992. Carnivorous plants: phylogeny and structural evolution. Science 257: 1491-1495.

Anitha, K. 2011. *Utricularia gibba*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2.

Anonymous. 1988. Wealth of India. Vol 3. Council of Scientific and Industrial Research (CSIR), New Delhi.

Parnell, J.A.N. 2005. An account of the Lentibulariaceae of Thailand. Thai Forest Bulletin (Botany) 33: 101-144.

Basak, R.K. 1975. Distribution of carnivorous plants in West Bengal. Bull. Bot. Surv. India 17: 97-107.

Bhowmik, S., and Datta, B.K. 2012a. Extended distribution of *Utricularia bifida* Linn. (Lentibulariaceae) from India. Researcher 4(3): 58-61.

Bhowmik, S., and Datta, B.K. 2012b. *Utricularia caerulea* L. (Lentibulariaceae) - A new record from Tripura, Northeast India. NeBIO 3(1): 35-38.

Bhowmik, S., and Datta, B.K. 2013. Pollen morphology of some carnivorous plants from Tripura, India. J. Fundamental Applied Sci. 2(2): 36-38.

Bordoloi, R.P.M. 1977. The pitcher plant *Nepenthes khasiana*. Sreeguru Press, Guwahati, India. 59 pp.

Chew, M.Y., and Haron, N.W. 2011. *Utricularia* (Lentibulariaceae) habitat diversity in Peninsular Malaysia and its implications for conservation. Gardens' Bulletin Singapore 63(1 & 2): 451-464.

Choosawad, D., Leggat, U., Dechusukhum, C., Phongdara, A., and Chotigeat, W. 2005. Anti-tumor activities of fucoidan from the aquatic plant *Utricularia aurea* Lour. Songklanakarin J. Sci. Technol. 27(Suppl. 3): 799-807.

Compton, H. 1909. The morphology and anatomy of *Utricularia brachiata*. The New Phytologist 4: 117-130.

Cross, A. 2012. *Aldrovanda vesiculosa*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2.

Deb, D.B. 1983. The Flora of Tripura State, Vols. I & II. Today & Tomorrow's Printers and Publishers, New Delhi.

Didry, N., Dubreuil, L., Trotin, F., and Pinkas, M. 1998. Antimicrobial activity of aerial parts of *Drosera peltata* Smith on oral bacteria. Journal of Ethnopharmacology 60(1): 91-96.

Dixit, S., and Bera, S.K. 2012. Pollen rain studies in wetland environ of Assam, Northeast India, to interpret present and past vegetation. International Journal of Earth Sciences and Engineering 5(4): 739-747.

Ellison, A.M., and Gotelli, N.J. 2001. Evolutionary ecology of carnivorous plants. Trends Ecol. Evol. 16: 623–629.

Fleischmann, A. 2012. The new *Utricularia* species described since Peter Taylor's monograph. Carnivorous Plant Newsletter 41(2): 67-76.

Gibson, R., Conn, B.J., and Bruhl, J. 2012. Morphological evaluation of the *Drosera peltata* complex (Droseraceae). Australian Systematic Botany 25(1): 49-80.

Hazarika, S., and Barthakur, S.K. 2012. Hydrophytic flora of Assam – I. five new records. Pleione 6(2): 401-405.

IUCN. 2013. IUCN Red List of Threatened Species. Version 2013.2. http://www.iucnredlist.org, accessed 12 December 2013.

Jain, S.K., and Sastry, A.R.K. 1980. Threatened plants of India – a state-of-the-art report. Botanical Survey of India, Howrah.

Janarthanam, M.K., and Henry, A.N. 1992. Bladderworts of India. Botanical Survey of India, Calcutta.

Jayaram, K., and Prasad, M.N.V. 2006. *Drosera indica* L. and *D. burmanii* Vahl., medicinally important insectivorous plants in Andhra Pradesh-regional threats and conservation. Current Science 91: 943-946.

Jebb, M.H.P., and Cheek, M.R. 1997. A skeletal revision of *Nepenthes* (Nepenthaceae). Blumea 42(1): 1-106.

Joseph, J., and Joseph, K.M. 1986. Insectivorous plants of Khasi and Jaintia Hills, Meghalaya, India: A preliminary survey. Botanical Survey of India, Calcutta.

Joseph, J., and Mani, J. 1982. One new species and one new record from India in the genus *Utricularia*. Bull. Bot. Surv. India 24(1-4): 108-111.

Juniper, B.E., Robins, R.J., and Joel, D.M. 1989. The Carnivorous Plants. Academic Press, San Diego, California.

Kamble, M.V., Harikrishnan, S., and Balakumar, P. 2012. *Utricularia caerulea* (Lentibulariaceae): a

new record to flora of Andaman & Nicobar Islands. Rheedea 22(2): 116-118.

Kato,Y., Mochida, M., and Koike, H. 2006. The northernmost locality of *Utricularia caerulea* L. (Lentibulariaceae) in Japan. The Journal of Japanese Botany 81(1): 41-43.

Köppen, W., and Geiger, G. (eds.) 1930–1939. Handbuch der Klimatologie. 5 vols., Borntraeger, Berlin.

Lal, J., Chaturvedi, S.K., and Shukla, B.K. 2003. *Utricularia striatula* Smith (Fam. Lentibulariaceae) from Nagaland. Abstract. 5th Indian Agricultural Scientists and Farmers' Congress, 15-16 Feb. 2003, University of Allahabad, Bioved Research and Communication Centre, Allahabad, India.

Lansdown, R.V., Knees, S.G., and Patzelt, A. 2013. *Utricularia striatula*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2.

Li, Z.Y., and Cheek, M.R. 2011. Lentibulariaceae. Flora of China 19: 480-491.

Majumdar, K., Datta, B.K., and Shankar, U. 2011. Community structure and population status of *Drosera burmanii* Vahl. with new distributional record in Tripura, India. Journal of Ecology and the Natural Environment 3(13): 410-414.

Mandal, A., and Mukherjee, A. 2011. *Nepenthes khasiana*: the pitcher plant needs attention for conservation. Current Science 100(6): 807.

Natarajan, K., Kottaimuthu, R., Balasubramanian, V., Pandian, P.A., Malaisamy, M., and Ponnuchamy, A. 2008. Note on the identity of carnivorous plants of Karungalakudi, Tamil Nadu, India. Ethnobotanical Leaflets 12: 1073-1077.

Oliver, D. 1859. III. The Indian species of *Utricularia*. J. Proc. Linn. Soc., Bot. 3: 170-190.

Panday, S., Sinha, B.K., and Karmakar, P. 2013. Three new additions for the state flora of Mizoram, India. Pleione 7(1): 266-269.

Parnell, J.A.N. 2005. An account of the Lentibulariaceae of Thailand. Thai Forest Bulletin (Botany) 33: 101-144.

Prasad, M.N.V., and Jeeva, S. 2009. Coal mining and its leachate are potential threats to *Nepenthes khasiana* Hook. f. (Nepenthaceae) that preys on insects - an endemic plant in North Eastern India. Biological Diversity and Conservation 2/3: 29-33.

Raju A., and Christina, A.J.M. 2013. *Drosera burmannii* Vahl.: Antioxidant potential in Dalton's Ascites Lymphoma (DAL) bearing mice. Journal of Medicinal Plant Studies 1(4): 152-159.

Rao, A.S., and Joseph, J. 1967. *Utricularia pubescens* Sm. – first report of its occurrence in India. Indian Forester 93: 32-33.

Rathore, T.S., Tandon, P., and Shekhawat, N.S. 1991. *In vitro* regeneration of pitcher plant (*Nepenthes khasiana* Hook. f.) – a rare insectivorous plant of India. J. Plant Physiol. 139: 246-248.

Rice, B.A. 2006. Growing Carnivorous Plants. Timber Press, Portland, USA.

Santapau, H., and Henry, A.N. 1976. A dictionary of the flowering plants in India. Publication and Information Directorate, New Delhi.

Saxena, H.O. 1965. *Utricularia pubescens* Sm. – a new record for India. Indian Forester 91: 73-75.

Sharma, B.K. 2012. Phytoplankton diversity of a floodplain lake of the Brahmaputra River basin of Assam, north-east India. Indian J. Fish. 59(4): 131-139.

Singh, B., Phukan, S.J., Sinha, B.K., Singh, V.K., and Borthakur, S.K. 2011. Conservation strategies for *Nepenthes khasiana* in the Nokrek Biosphere Reserve of Garo hills, Northeast, India. International Journal of Conservation Science 2(1): 55-64.

Singh, P., and Sanjappa, M. 2011. Flowering plants of Sikkim - An analysis. In: Biodiversity of Sikkim - Exploring and Conserving a Global Hotspot. Arrawatia, M.L., and Tambe, S. (eds.). Department of Information and Public Relations, Government of Sikkim, Gangtok. pp. 65-88.

Subramanyam, K., and Kamble, N. P. 1968. Chromosome numbers in certain Indian species of *Utricularia* L. (Lentibulariaceae). Proceedings of the Indian Academy of Sciences - Section B, 68(5): 221-224.

Suksathan, P., and Parnell, J.A.N. 2010. Three new species and two new records of *Utricularia* L. (Lentibulariaceae) from Northern Thailand. Thai For. Bull. (Bot.) 38: 23-32.

Takhtajan, A.L. 1986. Floristic Regions of the World. University of California Press, Berkeley and Los Angeles, California.

Taylor, P. 1989. The genus *Utricularia* - a taxonomic monograph. Kew Bulletin Additional Series XIV: London.

Venugopal, N., and Devi, N.R. 2003. Development of the anther in *Nepenthes khasiana* Hook.f. (Nepenthaceae), an endemic and endangered insectivorous plant of North East India. Feddes Repertorium 114(1–2): 69-73.

Venugopal, N., Devi, R.K., and Rao, C.S. 2007. An interesting observation on the mycorrhizal symbiosis in the insectivorous plant, *Drosera peltata* Sm. in Meghalaya, North-East India. Carnivorous Plant Newsletter 36(1): 9-13.

Wikipedia. 2013. http://en.wikipedia.org/wiki/List_of_Nepenthes_species, accessed 11 December 2013.

Yee, C.M., Rahman, R.A., and Haron, N.W. 2012. Micro-structure studies on *Chirita* and *Utricularia* of peninsular Malaysia. Pak. J. Bot. 44(6): 2063-2066.

Zaman, M., Naderuzzaman, A.T.M., Hasan, M., and Naz, S. 2011. Ecology, morphology and anatomy of *Aldrovanda vesiculosa* L. (Droseraceae) from Bangladesh. Bangladesh J. Bot. 40(1): 85-91.

Zhuang, X. 2011a. *Drosera peltata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2.

Zhuang, X. 2011b. *Utricularia bifida*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2

Ziemer, B. 2010. Exciting conservation news: The Rare *Nepenthes* Collection project! Carnivorous Plant Newsletter 39(3): 67.

Climate change is eliminating *Pinguicula macroceras* Link habitat in Montana

Natch Greyes • 272 N. Main Street, Apt. 2 • Concord • New Hampshire 03301 • USA • natch.greyes@gmail.com

Keywords: climate change, *Pinguicula macroceras*, Montana, Glacier National Park.

The damage caused by climate change to plant communities is often obscured by a confluence of causes and vague deadlines, but in Montana there is an exception to that trend. The National Park Service in Montana has been leading efforts to document glacial melting. In the process, they have incidentally recorded ongoing damage to the handful of colonies of *Pinguicula macroceras* Link (Rice *et al*. 2008) that occur in Glacier National Park.

Pinguicula macroceras is a rare species in Montana (Anon. 2013b). It occurs only in the alpine zone of Glacier National Park (Fig. 1) and relies heavily on glacial melt for its water supply (Bloom, pers. corresp.). Since 1933, twelve colonies, in six mapped clusters, have been discovered (Anon 2013a). At least seven of those colonies, comprising five clusters, are found in areas likely fed by glacial melt (Anon 2013a).

Historically, *P. macroceras* has been documented north of Logan Pass, at Grinnell Lake, Grinnell Falls, and at Iceberg Lake (Casper 1962). More recently, *P. macroceras* has been documented at six different locations with seven colonies in the central part of Glacier National Park ranging from the head of Swiftcurrent Creek southeast to Blyth Creek and five colonies along Lee Creek, including the well-known populations along the "weeping wall" near Logan Pass (Bloom, pers. corresp.). Most observed colonies range in density from one to seven plants (Bloom, pers. corresp.; Anon 2013b).

Since 1900, the mean annual temperature for Glacier National Park and its surrounding region has increased 1.3°C, which, combined with longer and hotter summers, less snowfall and more rain, has led to unsustainably increasing glacier melt rates (Fagre 2013). Ordinarily, glaciers act as slow-releasing banks of water for alpine regions. While winter snowpack is helpful in supplying plants with water during the beginning of their growing season, by midsummer's end the winter snowpack has usually finished melting. At that point, glacial runoff is the only reliable water supply for alpine communities.

The largest colony observed to date by the author in the central part of the park, was approximately 6 km along a popular alpine hiking trail. The precise location of this colony is being withheld to prevent poaching. This location holds approximately thirty plants. The colony exists in the tiny S-bend of a small alpine stream fed by glacial melt, which traverses the alpine trail at an elevation of approximately 1600 m. At that location, there is no protection from the glaring sun or the deep snow packs that cover the

Figure 1: Typical alpine habitat in Glacier National Park, Montana.

mountainside for months on end. The plant species face a constant threat of desiccation due to the harsh, dry winds that blow over the craggy peaks and the hot sun that beats down on the rocky alpine soil. Once the remnants of the glacier melt completely, the stream will dry and the colony will die.

The colony of *P. macroceras* is able to survive in such a harsh and arid environment only because of the intersection of the nearly-vertical stream formed by glacial melt and a large boulder positioned in a way that allows a slow, steady stream of water to seep over its surface. That seeping water is just slow enough that a spongy moss has been able form a stable growing environment for *P. macroceras* and associated non-carnivorous plants.

Current projections indicate that the glacier located 300 m above the plants will be gone by 2020 (Minard 2009). The alpine ecosystem here, like most alpine ecosystems throughout Glacier National Park and the surrounding region, has a poor soil that does not retain water well. Once the remnants of the glacier finish melting, the slow, continuous release of water that feeds the stream will stop, and the vegetation that depends on it, including the colony of *P. macroceras*, will become desiccated and die.

Of the six mapped occurrences of *P. macroceras* within Montana, at least three occur near a stream fed by glacial melt and two others occur near lakes left by retreating glaciers (Anon. 2013b). While the continued existence of the colonies upon the shores of the lakes left by retreating glaciers may persist for a time, the colonies that occur near streams fed by glacier melt will almost certainly perish by the time the last glaciers have left Glacier National Park (Fagre 2013).

References

Anon. 2013a. *Pinguicula vulgaris*. University of Montana Herbarium. http://herbarium.dbs.umt.edu/database/DisplayItem.aspx?id=Pinguicula%20vulgaris, accessed 30 September 2013.

Anon. 2013b. California Butterwort — *Pinguicula macroceras*. Montana Field Guide. Montana Natural Heritage Program. http://FieldGuide.mt.gov/detail_PDLNT01040.aspx, accessed 30 September 2013.

Bloom. S. 2013. Personal Correspondence. 24 September 2013. On file with author.

Casper, S.J. 1962. On *Pinguicula macroceras* Link in North America. Rhodora 64(759): 212-22.

Fagre, D. 2013. Glacier monitoring studies. Northern Rocky Mountain Science Center (NOROCK). United States Geological Survey. http://www.nrmsc.usgs.gov/research/glaciers.htm, accessed 30 September 2013.

Goldstein, A., and Howard, K. 2013. Glacier National Park prepares for ice-free future. News Watch. National Geographic Water Currents. http://newswatch.nationalgeographic.com/2013/09/10/glacier-national-park-prepares-for-ice-free-future/, accessed 30 September 2013.

Minard, A. 2009. No more glaciers in Glacier National Park by 2020? National Geographic News. http://news.nationalgeographic.com/news/2009/03/090302-glaciers-melting.html, accessed 30 September 2013.

Probatova, N.S., Barkalov, V.Y., and Rudyka, E.G. 2004. Chromosome numbers of selected vascular plant species from Sakhalin, Moneron and the Kurile Islands. Bulletin of the Hokkaido University Museum 2:15-23. http://eprints.lib.hokudai.ac.jp/dspace/handle/2115/47769, accessed 30 September 2013.

Rice, B., Yin, A., and Morimoto, G.E. 2008. Observations of isolated *Pinguicula* populations in the western USA. Carniv. Pl. Newslett. 37(4): 100-109.

International Carnivorous Plant Society
2012 Conference Field Trip

Matthew M. Kaelin • Bellmore • New York • USA • mattfromquogue@aol.com

It was almost midnight on the 15th of August and there I was driving down some highway in North Carolina. Koji Kondo, Naoki Tanabe, Tsutomu Takahashi, and Yasuhiko Matsushita from Japan were all in the back of the van. Daryt Frank from Los Angeles was sitting in the passenger seat next to me and I looked in the rearview mirror to find Joel Koos from Long Island, New York following behind me. In that van were Dennis Balsdon and Tim Bailey from England, Marcel van den Broek from Holland, then Adam Cross and Robert Gibson from Australia.

We were all attendees of the 9th International Carnivorous Plant Society Conference, which was hosted by the New England Carnivorous Plant Society in Seekonk, Massachusetts. Once the conference was over, there were additional field trips available (Fig. 1). On the first day, there was a tour of two former commercial cranberry bogs in Cape Cod, to view some of the last known *Drosera filiformis* locations in the wild in New England. The New England Carnivorous Plant Society had provided a bus to transport the group and the first stop was Mother's Bog in Brewster, Massachusetts, owned by the Brewster Conservation Trust. Near the cultivated flatlands where the commercial harvests once took place, there was a shallow borrow pit which collects rain water on and off throughout the year, which contained a plant community of a coastal plains pond. *Drosera filiformis* along with the other native New England sundews, *D. intermedia* and *D. rotundifolia* were found there along with *Sabatia kennedyana*, *Coreopsis rosea*, and the clubmoss *Lycopodiella appressa*. The next stop was in nearby Harwich to visit the Bank Street Bog owned by the Harwich Conservation Trust, which is very similar to, but much larger than, Mother's Bog. We found another healthy population of *D. filiformis* with *D. intermedia*, and some *Utricularia*.

The final destination for the day was a *Sarracenia purpurea* population in North Dartmouth, Massachusetts. After bushwhacking through the brush and trudging through standing water, the group

Figure 1: The 9th International Carnivorous Plant Society Conference field trippers.
Back Row (left to right): Marcel van den Broek, Sheila Stewart, Mark Todd, Tim Bailey, Robert Gibson, Dennis Balsdon, Peter D'Amato, Damon Collingsworth.
Front Row: Tsutomu Takahashi, Koji Kondo, Yasuhiko Matsushita, Naoki Tanabe, Matt Kaelin, Adam Cross, Joel Koos, Daryt Frank.

came across some old abandoned railroad tracks before we got to a small, open swamp that supported dozens of *S. purpurea* in the hummocks of *Sphagnum* surrounded by an Atlantic white cedar forest.

The second day of the field trip was mostly spent travelling to and settling in to Wilmington, North Carolina. On the third day, we contacted Mark Todd, the head of conservation for the North American Sarracenia Conservancy (NASC), who had offered to be our guide since he lives in the area and knows it well. Mark and Sheila Stewart, the treasurer of NASC, met us at our hotel in Wilmington, North Carolina. The first place to visit was the famous Green Swamp. We parked at the front gate and wandered over to an adjacent pond which had thousands of *Utricularia juncea* in flower with *Drosera intermedia* accompanying them. We followed a trail into the Green Swamp itself, which is open and grassy savannah land with scattered trees thickening around the edges of the clearings into denser thickets of brush and forest. There were longleaf pines (*Pinus palustris*) in the bottlebrush stage of their development, looking pre-historic and almost like something from the ancient Carboniferous Period. We followed a wooden planked trail cut through a forest wall thick with trees and brush, and once on the other side, we discovered the first Venus Flytraps (*Dionaea muscipula*) of the trip, accompanied by some fine examples of *Drosera capillaris*. We continued on and found great clusters of *Sarracenia flava*, many of which had resident lynx spiders living on them. The *S. flava* seemed to be the dominant of the carnivorous plants here with many clumps being typical var. *flava*, with some var. *cuprea*, var. *maxima*, and possibly var. *rugelii*. As we were winding our way across the grassy savannahs with their intermittent trees providing all too-little shade, we came across *S. minor* and *S. alata*. There were a couple of spots that had *Drosera brevifolia* scattered about. The air was thick and heavy with humidity and the sun and heat were taking their toll, so we decided it was time to march back to the vans and get back on the road.

Our next stop was Myrtle Head, which is a location where NASC had sponsored a prescribed burn to clear the competing vegetation and restore the carnivorous plant habitat. The ditches alongside an open and sunny trail were filled with carnivorous plants. There were outstanding Venus Flytraps growing at the open sunny edges of the roadside ditch with the stiff, upright leaves normally seen in the spring. *Drosera capillaris* and *D. brevifolia* were scattered about as well as some of the finest specimens of *Pinguicula lutea* we would see. *Sarracenia flava* and *Utricularia juncea* were growing in shallow puddles. The burn area appeared to be desolate scorched earth, but we saw the emergent growth of many *Sarracenia purpurea* and *S. flava* poking from the charred remains of what had been competing vegetation.

We then set off for an area known as the Old Dock, one of the few surviving natural habitats of *Drosera filiformis* in North Carolina. Unfortunately, in August the plants seemed to have already finished for the season, having shrunk back to their dormant buds. The growing season for these plants starts and finishes much earlier than their northern cousins in Cape Cod. Nearby there was a long dirt road through some woods that had trenches along both sides filled with fairly deep water. On the wet slopes of these trenches were the best *Sarracenia minor* seen so far and quite a few *S. purpurea*.

The last location for the day was a natural bog depression behind the Alderman Elementary School named the Stanley Rehder's Plant Trail. This great site was cultured by Stanley Rehder, known locally as "The Flytrap Man". A walking path was built through the bog that contains the native North Carolina carnivorous plants with some non-native *Sarracenia leucophylla*. This was used by Rehder as an educational tool to introduce people, especially children, to these wonders of the natural world. Stanley Rehder died on 1 October 2012 at the age of 90 years — just a few weeks after we visited the Stanley Rehder's Plant Trail.

Darkness was falling, and so we trudged back to the vans, closing out our first long and exhilarating day in the field. At the hotel, we chanced across Peter D'Amato and Damon Collingsworth from

the Sonoma Valley of California, who had just arrived from touring the carnivorous plant habitats of New Jersey. The two of them were here to join our group for the rest of the North Carolina tour.

On the fourth day of the expedition we were to visit two large locations managed by The Nature Conservancy that are normally closed to the public, and so this should be quite the opportunity for us indeed. Our first destination was the Mclean Savannah where we met Angie Carl of The Nature Conservancy. The Nature Conservancy periodically burns the savannahs to keep them open from the encroaching grasses and woody shrubs. When we stepped out of our vehicles, we found hundreds of little *Drosera brevifolia* scattered at our feet filling in the sandy areas in any open spaces between the low grasses. We took a short walk and came across our first Flytraps of the day, as well as some splendid *Drosera capillaris*. As we continued down the trail, we found more and more Venus Flytraps, large and richly colored from basking in the full sunlight (Fig. 2). The wet soil they were growing in began to transition to full puddles of water and so we backtracked. We eventually came across huge numbers of Flytraps in the middle of the trail; their many gaping mouths emerging from the greenery of the surrounding plants. We understood how they received the common name of meadow-clams as only the traps were visible, poking out and resting upon a bed of the other low-growing vegetation with their open mouths appearing as indeed, a bed of clams on the seafloor.

Figure 2: Detail of *Dionaea muscipula* traps in a sunny, wet area in the Mclean Savannah.

These were pleasant woods to walk through, with pockmarked and ruddy sandy trails cutting through the forest of pine trees surrounded by dense brush where the land is fairly flat, with little perceptible variation of elevation.

We continued on to the next location managed by The Nature Conservancy known as Shaken Creek. Here The Nature Conservancy partners with a hunting club that owns the land. As we were driving, the surrounding forest vegetation began to open up and we started to notice *Sarracenia flava* growing along the edges of the road, and then there were more and more of them until we came upon fully open fields with numerous, huge stands of *S. flava* pitchers all thrusting out from the earth in great jagged clumps scattered about the landscape (Fig. 3).

We promptly parked the vehicles and embarked into these broad fields where we found three varieties of *Sarracenia flava*: the lovely typical variety *flava*, the elaborately veined variety *ornata*, and the striking red-throated variety *rugelii*. A green anole (*Anolis carolinensis*) was perched on top of one of the *Sarracenia flava* pitchers (Fig. 4). Luckily, he remained completely unconcerned by the presence of so many photographers crowding around him. A moment later he jumped across to another pitcher to catch and eat a cricket before disappearing into the tall grasses.

There were also enormous spreading clusters of *S. purpurea* subsp. *venosa* bearing dozens of their squat, bulbous pitchers and also their hybrid with *Sarracenia flava*: *Sarracenia ×catesbaei*. There were the many low-growing carnivorous plants in the grassy undergrowth: *Dionaea muscipula*, *Dro-*

Figure 3: Large population of *Sarracenia flava* in open field of Savanna land in Shaken Creek location.

Figure 4: Anole lizard resting on the pitcher lid of *Sarracenia flava* in the Shaken Creek location. The fleeting mascot of the 2012 ICPS Conference field trip.

sera capillaris, *D. brevifolia*, and *Pinguicula lutea*, all interspersed throughout the Savannah understory, competing with and contemplating one another's strategies.

While we were moving across this field, searching for any carnivorous plants we could find, we came to a spot where the brush had thickened and then opened to a pocket with some small rain-fed ponds. Here we found *Utricularia purpurea*. Its tell-tale lovely miniature purple flowers poked out through the surface of the pond's water with the casual nonchalance as if it were a terrestrial wildflower in the soil. However, when we looked past the water's dark surface to the scenery below, we saw continuing from these flowers, a great branching network of stolons from which sprout the suspended bladders that capture and ingest countless minute creatures of the pond.

Just around the corner, there was much less grass and far fewer *Sarracenia flava*. Instead the area contained mostly lower growing plants with *Dionaea muscipula*, *Drosera capillaris*, *D. brevifolia*, and *Pinguicula lutea* in the understory. The competing plants were few, the habitat was open, and so the plants received much more light and certainly had much better color. Clouds came rolling across the sky and began to dull the sunlight, and by now it was time for us to be on our way. As we were driving out of the preserve, we chanced across some puddles on the side of the road which supported such an interesting habitat that we stopped to investigate. What first caught our attention were the wild bog orchids, but we also found numerous examples of *Drosera intermedia* spreading prolifically around the habitat, and, most interesting, were the *Utricularia subulata* growing in the wet sand with their flowers unopened — identified by their short, crooked, and wiry flower-scapes.

On the morning of day five, we were driving our caravan of three minivans and a sedan through the cozy communities of Carolina Beach with their colorful houses and shops lining the road. First we stopped at the Kure Beach fishing pier to visit the picturesque beaches. Then we continued further down Cape Fear to visit the Fort Fisher State Historic Site which is where a pivotal battle of the American Civil War took place and is now a National Historic Landmark. From there we continued to the dock where we were to take a ferry across Cape Fear River to pay homage to Arthur Dobbs' grave.

After disembarking from the ferry, we soon arrived at the ruins of the Brunswick Town Historical Center which today are part of the National Register of Historic Places. Unfortunately, the graves are all unmarked so it was impossible to identify which grave was indeed Arthur Dobbs'. Still, we were able to pay our respects to the one who discovered the Venus Flytrap, arguably the most famous and recognizable carnivorous plant of them all. Not far from the historical center, we saw a large alligator sunning himself on the roadside bank of Orton Pond. The surrounding trees had great amounts of the Spanish moss, *Tillandsia usneoides*, hanging from the branches. We also stopped briefly at the Boiling Springs Lakes to visit their source.

These were all pleasant diversions, but now it was time for us to get back to the wild natural habitats of North Carolina's carnivorous plants. So Mark led us through a nicely manicured suburban neighborhood before we came to an opening in the surrounding woods. We entered through this opening and drove along dirt roads where we passed many signs advertising for future development. We noticed the woods around us were cleared. Extending from their border, there were miniature cliffs that descended to level sandy plains. There were ruts in the ground with puddles of water. The carnivorous plants each had their preferred zones of the habitat. For example, Venus Flytraps seemed to prefer the crests and bottoms of the miniature cliffs and the multitudes of *Drosera brevifolia* favored the drier outskirts of the sandy plains. Large *Drosera intermedia*, with great skirts of leaves around their raised rosettes, emerged from the wettest areas and finally the *Sarracenia flava* were found standing along the edges of the puddles. We found the most exceptional examples of *Drosera capillaris* along the wetter centers of the sandy plains (Fig. 5).

Next we were on our way to a location that was notable for having Venus Flytraps with an exceptionally red coloration. The place was also known for having a wide range of other carnivorous plants such as: *Sarracenia rubra*, *S. purpurea*, *Drosera capillaris*, *D. brevifolia*, *D. intermedia*, and *Utricularia inflata*. The habitat was to be similar to the last, with wet ruts along the side of a dirt road through the woods where the carnivorous plants would grow along the outer edges of the path. But when we arrived, we found to our shock that the entire road was plowed over with wood chips to stabilize the roads for logging trucks to drive through the area. The place was a disaster site for carnivorous plants, and we were deeply saddened by this sight.

Figure 5: *Drosera capillaris* plant in wet sandy soil along a trail in the woods near a suburban neighborhood.

With heavy hearts from that experience, we continued on to the next location which did lift our spirits. Along the side of an unassuming paved road near Camp Pretty Pond, there was a low, wet ditch. After this ditch, there was a slope leading up to the higher elevation where the drier pine forest, thick with scrub brush, took over. The exposed and sunny slope towards the road was where the Venus Flytraps could be found. They grew in great batches with richly colored voracious mouths popping out from the surrounding grasses and emergent shrubs.

At this point, the day was ending and we collected ourselves to depart from that last location just as the final glow of daylight was leaving the sky. The next morning we were to set out towards Raleigh Airport and continue on our separate ways, but for that particular moment, we were all standing around the cars on the side of the road and having the time of our lives laughing about all the great things we had seen and done throughout our fantastic voyage on the International Carnivorous Plant Society 2012 Conference Field Trip.

An extended field trip in the USA

Marcel van den Broek • Marcel@carnivorousplants.org

After attending the 2012 ICPS Conference, I went on the field trip that the NECPS so kindly had organized. Since Matt Kaelin has an article about this organized trip in this issue of CPN, I'll skip that part and will write about my "after trip".

So, you are from Europe, you're in North Carolina and you still have a little less than two weeks holiday left. What do you do? Visit the Grand Canyon? Do some storm chasing? Not this CP-nut.

Together with DJ Frank and Adam Cross, I rented a car and went on an extended field trip.

The first leg was from North Carolina to Georgia and specifically the Atlanta Botanical Garden. For this part of the trip we also had the great company of Robert Gibson, who unfortunately had to leave us after this visit to go on to California.

The first contact with Atlanta was harsh and a good lesson in picking hotels from the Internet. While the hotel looked fine on the web, in reality it was plain filthy. I also wasn't feeling very comfortable, arriving in a "somewhat disadvantaged" neighborhood just before midnight with the only white faces around being that of the four of us is somewhat unnerving.

The next day however totally made up for this less than great meeting with Atlanta. Ron Determann of the Botanical Garden was very kind in giving us a great VIP tour of this amazing institute.

This is really a magnificent garden. We looked at many awesome plants in the parts of the greenhouses that are open to the public. Most notable were an abundance of orchids, a great *Nepenthes* display and a *Heliamphora* display that just left us stunned with the most huge clumps of these plants I have ever seen…and all that just along a walkway in a greenhouse in a big city (Fig. 1).

Figure 1: *Heliamphora* display at the Atlanta Botanical Garden.

Figure 2: *Sarracenia pupurea* subsp. *venosa* var. *montana* at the Atlanta Botanical Garden.

Next we went behind the scenes. Here Ron has a huge collection of rare *Sarracenia*'s, some originating from sites that no longer exist. Rubra's, leuco's, psittacina's everywhere and sitting at the side of the greenhouse was tray after tray of *Sarracenia pupurea* subsp. *venosa* var. *montana* (Fig. 2). I have never seen so many montana's at one place before, not even in commercial nurseries. A truly living museum of genetic diversity and exactly what projects like the Ark of Life are trying to establish, *ex situ* conservation. Hopefully we can connect these projects in the future. The most impact (in real force) of our behind the scenes trip was the climate control system. Large blowers and humidifiers handle the serene climate in the still greenhouses by making an awful lot of noise and creating massive pressure differences (you actually had to hold on to the doors) in the basement.

After signing the guestbook and saying our thanks and goodbye to Ron and Robert the remaining three of us started on our next big drive to Okefenokee. We had rented a cabin at Stephen C. Foster State Park and wanted to go have a look at the giant minors that get their name from this area. The trip turned out to take longer than we thought and we arrived literally with minutes to spare before closing time. Great accommodations and a really nice park, highly recommended. Next day we started driving around a little and spotted some alligators, birds, deer, and even a couple of cp's but already we were seeing the signs of what our later boat trip would confirm. The area had been hit by a massive fire and since then had received little rain so much of the land was still black and gray. Our first disappointment on this trip, but that's Mother Nature for you. Still a pleasant two days at a beautiful park and I will definitely be back when it has recovered.

After Okefenokee we went to Florida, specifically the Apalachicola part. Here we were driving on the directions kindly provided by Brian Barnes. We looked at several locations and the absolute stunner was a site near Sumatra. This site is well known for its gorgeous red-tubed plants, *Sarrace-*

Figure 3: *Pinguicula planifolia* in the Apalachicola near Sumatra, Florida.

nia flava var. *rubricorpora*, and we found lots of them. A site of truly breathtaking beauty. We also found huge, and I do mean huge like the size of your hand, dark colored specimens of *Pinguicula planifolia* (Fig. 3).

This site is well worth getting your feet wet and suffering a minor meltdown in the Florida sun.

The last site we planned on however was our second (and last) disappointment of this trip. We were to visit the famous Tate's Hell leucophylla's. Having found the other sites with relative ease thanks to Brian's clear instructions, we couldn't find a leuco. We even called Brian and did the "take a left, 300 meters" wireless guided tour but still we came up at the same spot. A barren piece of land with heavy construction equipment on it. A later visit by Stewart McPherson, who had been there before, confirmed that the roadside leuco display was indeed wiped out, destroying one of the most accessible leucophylla sites in Florida and also one of the genetically most pure populations at that. Luckily there are apparently some of these plants still surviving at more remote spots in this area, but a very sad loss it is.

Our final leg of the journey took us to Alabama. One does get around you might say. Adam had been talking at the conference to Brandy Midura and she really recommended that we visit Splinter Hill. We all knew the site by reputation so a decision was soon made and a hotel arranged. Brandy was even kind enough to join us for the exploration of this famous site when she heard we were going to visit the place, making the long drive from Texas. That actually is something I really like about this hobby and the people in it, everyone is so willing to share their experiences and show people around.

Splinter Hill was indeed stunning. Just a couple of steps from the parking spot a sea of white was greeting us, adding yet another unforgettable memory to an overall great holiday (Fig. 4). Plants

Figure 4: A sea of *Sarracenia leucophylla* at the Splinter Hill Bog Preserve, Alabama.

ranged from very red to almost pure white, with dozens of stunning forms that haven't made it into cultivation. As this is protected land, they probably never will make it into cultivation. Though sadly, we did find here (and in nearly every other place we visited) signs of poaching.

Next morning we were saying goodbye to Brandy and we drove back to Florida were Adam had to take a plane the next day to go home to Perth. After dropping him off, DJ and I raced back to Raleigh, North Carolina to turn in the car early next morning and take the planes that would take us to Los Angeles and Amsterdam. We were fortunate with the things we saw on this trip and our luck held as all three of us made it home before Hurricane Isaac really messed things up.

I would like to thank Brian Barnes, Adam Cross, Ron Determann, DJ Frank, Robert Gibson, and Brandy Midura for their information, company, and helping make this a great holiday trip for me.

Growing tuberous sundews

Greg Bourke • PO Box 3049 • Bilpin • NSW 2758 • Australia • orders@captiveexotics.com

The tuber forming sundews (*Drosera* spp.) are the most diverse group in the genus. They are loosely divided into four groups based on habit. These are climbing, erect, fan-leafed, and rosetted. The climbing species include giants like *D. erythrogyne* and *D. pallida* that climb up to 3 m high, gluing their leaves to surrounding objects for support. The erect *D. gigantea* is truly spectacular reaching 60 cm tall with spreading branches festooned with sticky trapping leaves. The fan-leafed *D. rupicola* (Fig. 1) comes in lime green through various shades of orange, bronze through to deep red. In the rosette group, species like *D. erythrorhiza* subsp. *collina* (Fig. 2) and *D. bulbosa* subsp. *major* form huge rosettes exceeding 10 cm in diameter and are strong enough to bring down a dragon fly. The flowers of this group are equally as diverse in color (Fig. 3) many of which are sweetly scented. These characters have deservedly made the group desirable to collectors around the world, however many struggle to grow them well or maintain them long term. Cultivation techniques differ, but generally growers opt for growing them in water trays in glasshouses. They dry plants out in summer and await new growth in autumn before rehydrating. I do things a little differently so thought I'd share some of my experiences with the aim of assisting others to enjoy this incredible group.

Figure 1. *Drosera stolonifera* subsp. *rupicola* Emu Rocks.

Figure 2. *Drosera erythrorhiza* subsp. *collina* John Forest National Park Western Australia.

I have the luxury of living in the cool climate of the Blue Mountains in Australia. Here, winters are cool with daytime temperatures rarely exceeding 20°C and nights rarely below -5°C. Summer temperatures are fairly mild with temperatures between 15°C and 35°C. These temperatures are a little cooler than many species experience in the wild. In the wild, tuberous sundews receive their rainfall (generally less than 800 mm) in the cooler months and almost no rain in the

Figure 3. *Drosera stricticaulis* from South Australia.

summer. At my place in the Blue Mountains, annual rainfall is 1200 mm with the wetter period being the summer months. You would expect problems with cultivating tuberous plants in these conditions, but this is not the case if you follow a few simple rules.

Pot size is important for these plants to thrive long term (Fig. 4). Small pots dry out too quickly and temperatures in the soil fluctuate rapidly. For these reasons, I use 200 mm pots for all species. For the majority, pots are placed on open benches outdoors. This allows good drainage. A few species do like to be wet in winter and these are placed in water trays. These include *D. gigantea*, *D. fimbriata*, and *D. intricata*.

I have experimented with more than a dozen different soil mixes but have settled on just two. For the majority of species, a mix of 50% 8/16 screened silica sand to 50% sphagnum peat moss. The correct sand is important for long term good growth, silica sand is the only sand I will use as it is generally very clean so impurities won't build up in your compost, and also it has rounded edges and therefore does not lock together like sharp edged sand. Sharp edged sands, like river sand, will work for a few seasons but eventually the grains interlock and compact. The tuber then has trouble breaking through the compost and eventually starts to go backwards. The sand used in pool filters is generally silica sand of the grade that is suitable for tuberous sundews. If you live in the U.S. or Europe and find sand hard to come by, speak to your local pool supplier. The second mix I use uses the same sand and peat, but with more sand, up to 80%. This is used for the species that occur in deep sand in the wild like *D. zonaria*, *D. zigzagia*, and *D. bicolor*.

Watering is generally done by nature although I do hand water twice per week between April and October (remember this is southern hemisphere) if it doesn't rain. In a free draining mix, plants can be watered excessively with no ill effects, even through the dormancy period!

Every five or so years it is worth repotting your tuberous sundews for three reasons. First, over time the tubers can work their way down to the bottom of the pot, so this is a good time to reposi-

Figure 4. *Drosera erythrorhiza* subsp. *squamosa* grow well in a large pot.

Figure 5. *Drosera erythrorhiza* subsp. *erythrorhiza* tubers from a single pot that had not been repotted for almost 10 years.

tion them. Second, many species will asexually reproduce daughter tubers and these can be collected and used to trade or make another pot (Fig. 5). Finally, some species have a habit of spreading seed through other pots (*D. peltata*, *D. auriculata*, and *D. hookeri* being notorious) and over time these germinate and form plants that will contaminate even the best managed collection, so it pays to sort through the compost and remove these invaders.

Tuberous sundews enjoy high light levels. My plants receive direct sunlight for most of the day but are protected from afternoon sun so as to avoid over heating of the media.

If you live in a region where temperatures are comparable to those mentioned above, I suggest you give tuberous sundews a go. Start with an easy species like *D. auriculata*, *D. peltata*, *D. hookeri*, *D. macrantha*, or *D. whittakeri*. Using the above growing method you will be rewarded with a beautiful display year after year.

Keywords: cultivars, *Dionaea* 'Sonic', *Sarracenia* 'Yellow Eel'.

Sarracenia 'Yellow Eel'

Submitted: 16 February 2014

Sarracenia 'Yellow Eel' was produced by transferring the pollen from a *S. alata* × *psittacina* to a *S. alata* seed parent on 3 October 2007. The seeds began germinating on 23 June 2008. Plants are currently in their 5th year of growth. The pollen parent has pitchers that are red in color with small white fenestrations and veining around the hood and top section of the pitcher, and has a closed hood with a small opening that represents the pitcher's mouth. Its flowers produce red petals. The seed parent is a very vigorous plant that produces tall green pitchers about 60 cm tall, has light red venation on the pitcher's exterior and more prominent veining on the interior surface, with the underside of the lid red. It produces light green to yellow petals.

Figure 1: *Sarracenia* 'Yellow Eel'.

The resulting *Sarracenia* 'Yellow Eel' produces tall pitchers that are light green in color with younger pitchers appearing green yellow (Fig. 1). It has light red venation on the pitcher's external surface and some white fenestrations on the pitcher's top section. The hood covers the pitcher's mouth and looks similar to *S. minor*, except this plant has no *S. minor* ancestors. The tip of the hood is pointed. It is a strong plant similar to the *S. alata* parent and very attractive. The tallest pitcher currently measures just over 50 cm tall and has an ala. The top region of the pitcher is inflated. Older pitchers have more prominent veining on their external surface, becoming green on the underside of the lid red, as in the *S. alata* parent.

The term "Yellow Eel" refers to both the spectacular color of the new pitchers as well as their shape.

Sarracenia 'Yellow Eel' must be reproduced vegetatively to preserve the characteristics of the cultivar.

—Steve Amoroso • Australia • steve.1600@yahoo.com

Submitted: 29 January 2014

This plant was originally selected in September 2011 because its appearance was identical to *Dionaea* 'Cupped Trap', but with dark red traps. In the second year, the plant lost its "Cupped Trap appearance" and began to develop dentate-like teeth, but the trap was clearly not typical. When the plant finally reached a mature size and flowered for the first time, its strange teeth remained very different throughout the year. The teeth range from long with alternating short and thin teeth (Fig. 2), to short and triangular teeth like a mixture of sawtooth and dentate (Fig. 3). Due to the convexity of the traps, they close very fast. Summer leaves can be 20 cm long.

Figure 2: *Dionaea* 'Sonic' trap with long thin teeth (left) and with alternating long and short teeth (right).

The name *Dionaea* 'Sonic' was coined in August 2013 after Sonic the Hedgehog, because of the similarity between teeth and the cartoon hairs, and the speed with which the trap closes.

Dionaea 'Sonic' must be reproduced vegetatively by rhizome or leaf cuttings to preserve the characteristics of the cultivar.

Figure 3: *Dionaea* 'Sonic' trap with short triangular teeth (left) and sawtooth-like teeth (right).

—Yuri Sarzi • via Immacolata 56 • 20023 Cerro Maggiore • Milano • Italy