CARNIVOROUS PLANT NEWSLETTER

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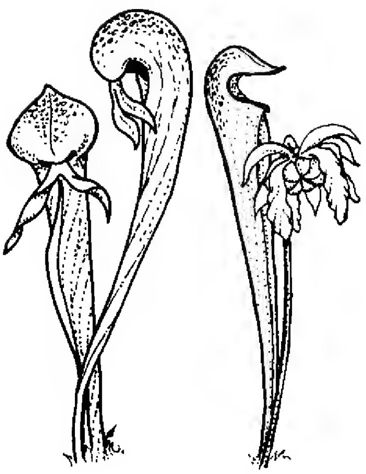

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Front Cover: *Triphyophyllum peltatum* with three glandular leaves in the greenhouse of the Botanical Gardens of Bonn. Photo by Katja Rembold. Article on page 71.

Back Cover: A 35-cm-long pitcher of *Nepenthes palawanensis*, a close relative of *Nepenthes attenboroughii* from Palawan, Philippines. Photo by Stewart McPherson. Article on page 89.

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

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Contents

Exciting conservation news: The Rare Nepenthes Collection Project!

It is a sad fact that more and more plant and animal species are becoming increasingly threatened with the risk of extinction. Conservation of carnivorous plants and their habitats is made difficult due to their environmental sensitivity, high rates of endemism, (often) slow reproductivity, high horticultural value, and many other factors. *Nepenthes* are among the carnivorous plants most adversely effected by the activities of human kind, with one species (*N. thorelii*) already seemingly totally extinct (in the wild and in cultivation), and four further species (*N. aristolochioides*, *N. clipeata*, *N. khasiana*, and *N. rigidifolia*) increasingly jeopardized or already near extinct in the wild. The imperiled state of these *Nepenthes* makes the preservation of the genetic diversity in cultivation extremely important for their survival.

For this purpose, Stewart McPherson, well known for his magnificent books on carnivorous plants, has taken the initiative to form the Ark of Life Foundation. This non-profit effort will organize and build collections of rare plant species as an *ex situ* conservation approach to preserve and protect genetic diversity in the hope of supporting future reintroduction efforts. The first collection, or "ark", has recently been established as "The Rare Nepenthes Collection" and focuses on ensuring the continuing existence of *N. aristolochioides*, *N. clipeata*, *N. khasiana*, and *N. rigidifolia*.

The Rare Nepenthes Collection will preserve all cultivated lineages of these four species and obtain genetic material not yet in cultivation. Collaboration with local organizations in Indonesia and India is being developed to additionally raise awareness about the specific threats faced by these species and their habitats. The Rare Nepenthes Collection will be permanently housed at the Hortus botanicus Leiden, the Botanical garden of Leiden University, The Netherlands, with a formal agreement signed during the 2010 ICPS Conference at Leiden. The ICPS has supported and helped this important conservation effort and partially funded the establishment of The Rare Nepenthes Collection.

More information on The Rare Nepenthes Collection can be found at www.arkoflife.net. If you would like to help secure a future for these imperiled carnivorous plants, consider donating cuttings, seedlings of plants of the imperiled *Nepenthes* to The Rare Nepenthes Collection for permanent conservation so that the collection may grow. Alternatively, you can sponsor a new acquisition plant or donate specifically to help this important nonprofit effort. Please contact The Rare Nepenthes Collection at info@arkoflife.net for more information.

ICPS *Sarracenia alabamensis* Conservation in action!

Brian Barnes • ICPS Director of Conservation • brian@carnivorousplants.org

In May 2010, I had the privilege of visiting the rarest of *Sarracenia* at a site that is supported by the ICPS (see Figure 1). I was very excited about the chance to photograph and video this site to document our member's hard-earned dollars at work!

Using Splinter Hill Preserve (Alabama) as my base camp, I left very early the morning of May 21st to venture north through Alabama to this cherished site. I noticed how the terrain began to change. The lower lying pinelands and swamps turned into a harsher, rockier, and more hill-like environment. I also noticed the increase in that famous Alabama red clay; you know the kind you have to practically chisel off of your vehicle at day's end? Well, it was everywhere by the time I was 10 miles or so from my destination.

Keith Tassin of The Nature Conservancy was kind enough to guide me through the thickets of *Arundinaria*, a slender type of cane native to Alabama, and from which *S. alabamensis* derives its common name, "The Canebrake Pitcher Plant". Naturalist William Bartram once noted these massive stands of *Arundinaria* as he travelled through the region and described the cane as being "thick as a man's arm or three or four inches in diameter". Although the cane I witnessed was much smaller, I still enjoyed the gentle, rustling sounds the leaves made as welcomed breezes blew through them!

We finally came to rest on top of a gravelly clay hill. The soil here was fairly dry due to the higher elevation and blistering summer heat. However, the plants seemed to hang on, despite what seemed to me to be unusual conditions for *Sarracenia*. In fact, I was pleasantly surprised that they could grow so well in such a high clay type environment.

Figure 1: A fine healthy stand of *Sarracenia alabamensis in situ*.

Figure 2: *Sarracenia alabamensis* site before prescribed fire. Note encroaching grasses and woody shrubs.

Figure 3: *Sarracenia alabamensis* site after prescribed fire, which was made possible by donations from ICPS members. Note slower returning growth from woody shrubs and grasses, giving *S. alabamensis* a head start.

After exploring and shooting video, we ventured to a second area in this site. This area was different than the last, in regards to soil composition and surroundings. It is here that I saw the healthiest plants, which I attribute to the white, sandier soil that contained far less red clay, although it was also slightly gravelly. There was a constant water source in the form of a small natural spring that twisted and wound its way through the stands of plants. The seed set was incredible, with many large swollen capsules. What a great sight this was! Also, the size of the pitchers was easily twice the size as those at the first area. This particular area is on schedule to be burned in 2011, as the dense overgrowth is beginning to make itself known once again.

I must say that after visiting these fine plants in their natural habitat, I could clearly see the demand and extreme importance of land management actions such as prescribed fire. Without such measures, these outstanding colonies would quickly be choked out by fast growing, invasive overgrowth (see Figure 2).

Although burning the land clears the way for the *S. alabamensis*, it also clears the way for invasive woody competitors. However, the rhizomes of the pitcher plants can survive the extreme heat much better that those of its competition, thus giving the pitcher plants a much better head start (see Figure 2).

In Spring 2011, the ICPS is looking forward to reintroducing genetic material propagated from this site by Atlanta Botanical Gardens. Shortly after a burn, plants will be planted in the area that contains the natural flowing spring to ensure their needs are met perfectly with a more consistent water source. We will be soliciting for volunteers at this time to aid with their replanting. Please feel free to contact me if interested (brian@carnivorousplants.org) for details. Also, please help us preserve these plants for our future generations by visiting www.carnivorousplants.org and donating to the *Sarracenia alabamensis* Conservation Project.

Propagation of *Triphyophyllum peltatum* (Dioncophyllaceae) and Observations on its Carnivory

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Keywords: Cultivation: tissue culture, *Triphyophyllum peltatum* — physiology: *Triphyophyllum peltatum* — observations: *Triphyophyllum peltatum*.

Abstract

The temporarily carnivorous plant species *Triphyophyllum peltatum* is currently being cultivated at the Botanical Gardens of the Universities of Bonn and Würzburg. In both gardens, it developed carnivorous glandular leaves. This paper complements earlier communications concerning propagation and greenhouse cultivation of this rare West African plant species. We report on our progress with *ex vitro* progeny, on the cultivation of young plants of *Triphyophyllum peltatum,* and on observations on the carnivorous stage.

Introduction

The tropical liana *Triphyophyllum peltatum* is endemic to the rainforests of Western Africa. In its juvenile phase, it runs through a remarkable carnivorous stage as one part of a complex development. The plant is under-represented in private and scientific collections of carnivorous plants. The main reason is the limited availability of viable seeds or living plant material, combined with the difficult reproduction and cultivation. Thus, formation of carnivorous glandular leaves is not frequently observed in greenhouses. Furthermore, although this interesting plant has been known for 80 years, the glandular leaves have rarely been seen in nature due to its scarce occurrence and the difficult political situation in its native countries (McPherson 2008).

Discovery and Taxonomic History of *Triphyophyllum peltatum*

The plant, initially named *Dioncophyllum peltatum*, was discovered in 1928 (Hutchinson & Dalziel). It was first described as the third species of the genus *Dioncophyllum*, which had been known since 1890 (Baillon), but its taxonomic affiliation had always been doubtful. First it was supposedly related to the families Bixaceae and Passifloraceae or considered as a link between these two families (Baillon 1890). Later, *Dioncophyllum* was classified as a genus of the plant family Flacourtiaceae (Warburg 1895; Gilg 1908). A relationship to the carnivorous family Nepenthaceae was also dis-

Figure 1: Shoots of *Triphyophyllum peltatum* cultivated in vitro on Anderson medium. Photo by A. Irmer.

cussed (Sprague 1916; Hallier 1921). In the middle of the 20[th] century, Airy Shaw reviewed the genus *Dioncophyllum.* He described each of the three known species as independent monotypic genera (*Dioncophyllum tholonii*, *Habropetalum dawei*, and *Triphyophyllum peltatum*) and combined them into the newly generated family Dioncophyllaceae (Airy Shaw 1951). Today, this family belongs to the order Caryophyllales, which includes the related family Ancistrocladaceae and the likewise carnivorous families Nepenthaceae, Droseraceae, and Drosophyllaceae (Barthlott *et al.* 2007; Heubl *et al.* 2006).

The name *Triphyophyllum* refers to the complex life cycle of the liana, which is unique in the plant kingdom: three different types of leaves are produced consecutively during the development of *Triphyophyllum.* Although being a liana as an adult plant, it first develops lanceolate leaves on the condensed stem, followed by the occurrence of additional sticky glandular leaves that possess carnivorous properties. Finally the third type of leaves is formed, characterized by terminal hooks at the tip of the leaf, allowing the plant to climb up trees and shrubs of the rainforest (Porembski & Barthlott 2002). The seeds of *Triphyophyllum* constitute another fascinating feature, being the only seeds in the plant kingdom that are larger than the fruit (so-called secondary gymnospermy – Bringmann & Rischer 2001). The second part of the species name '*peltatum*' (Latin: pelta, Greek: pélte – πέλτη – = shield), refers to the discus-shaped seeds.

Triphyophyllum does not only possess remarkable botanical features, but is also interesting for its chemical constituents. It produces naphthylisoquinoline alkaloids (Bringmann & Pokorny 1995; Bringmann *et al.* 1998, 2003). These structurally, biosynthetically, and pharmacologically outstanding secondary metabolites exhibit promising bioactivities against the pathogens of several infectious diseases. As an example, the alkaloid dioncophylline C shows the potential to cure malaria-infected mice (Bringmann *et al.* 1992; François *et al.* 1997a, 1997b). More recently, other specific activities have been found, *e.g.*, against *Leischmania* parasites (Ponte-Sucre *et al.* 2007). Such naphthylisoquinoline alkaloids are only known from the three species of the Dioncophyllaceae family and in plants of the closely related, likewise small family Ancistrocladaceae.

In this paper we report on our progress in *ex vitro* progeny, on the cultivation of young plants of *Triphyophyllum peltatum,* and on observations on the carnivorous stage.

The Progeny of *Triphyophyllum* - from Axenic Cultures to Young Plants in the Greenhouse

The close cooperation of the research group in Würzburg with scientists from the Ivory Coast (in particular with Prof. L. Aké Assi) provided the Botanical Garden of the University of Würzburg with viable seeds of *Triphyophyllum peltatum*, *i.a.* in 1997. Most of the seeds were sown under greenhouse conditions, yielding plants that grew well for years in Würzburg (Bringmann *et al.* 2002). One of these plants was donated to the Botanical Gardens of Bonn.

In order to achieve axenic cell cultures for phytochemical studies and biosynthetic investigations on the naphthylisoquinoline alkaloids, some of the seeds from the Ivory Coast were surface-sterilized and sown under aseptic conditions on an artificial medium (Bringmann *et al.* 1999). From the sterile seedling, *in vitro* organ cultures (Bringmann *et al.* 1999) of *Triphyophyllum* (shoot cultures, see Figure 1) were successfully established. These sterile shoots were used as the parent material for inducing cell cultures (Bringmann *et al.* 2000), likewise opening the possibility for clonal propagation of this rare plant *in vitro*.

Figure 2: Sterile culture of newly rooted *Triphyophyllum peltatum*. Photo by A. Irmer.

The shoots grown aseptically appeared rootless, which prevented cultivation outside the flasks under greenhouse conditions. In order to generate rooted plants from the cultivated shoots, different phytohormone combinations – as usually used for root induction – were added to the medium. Unfortunately, this approach did not deliver completely satisfying results. Among the methods tested, the transfer of the shoots into sterile water was the most efficient one; under these conditions, at least 25% of the shoots showed good root growth (Bringmann & Rischer 2001).

Spontaneous rooting was occasionally observed during routine subcultivation of the shoots, especially if the shoots, instead of being transferred to fresh medium after four weeks, as usual, were kept on depleted medium for an extended time exceeding the usual four-week subculture interval.

Aseptic rooted plants were transferred to sterile Seramis® (Mars GmbH, Verden) substrate (see Figure 2) soaked with a solution of one-fifth strength MS macro elements (Murashige & Skoog 1962). The rootless shoots were transferred to fresh Anderson medium (Anderson 1980) to continue the sterile organ culture.

The small (and still sterile) plants were cultivated in Seramis® substrate for several weeks under the same growth conditions as previously applied to the shoots (Bringmann & Rischer 2001) so that they continued the root and shoot growth / development.

For the acclimatization to greenhouse conditions, which was successfully accomplished 3-4 months later, the plants were transferred into small pots filled with Seramis® and grown at 95% humidity and 25°C on a heated bed with constant light between 8 h and 20 h per day, if necessary using artificial daylight (Bringmann *et al.* 1999).

The plants in the greenhouse were watered daily with rainwater and in the first weeks without any fertilizer to avoid salt stress. During this time only some small leaves (max. 4 cm long) were produced. After 2–3 months in the greenhouse, a release fertilizer – 0.5 g MannaCote M6 (Wilhelm Haug GmbH & Co KG, Ammerbach) per pot – was added to improve nutrient supply of the young plants, which resulted in a slightly increased leaf size (*ca.* 5 cm long). The growth during summer time was very slow, whereas from the beginning of fall on, the growth rate and leaf size increased drastically (now up to 10-cm long leaves).

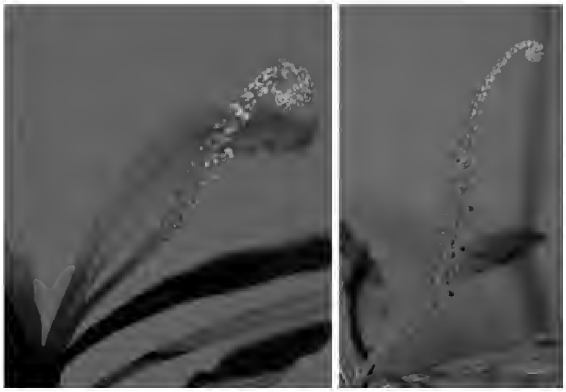

Figure 3: Different stages of the reverse circinate unfolding of a carnivorous organ of *Triphyophyllum peltatum* with first mature glands. The leaf-like part at the base is not developed at this stage. Photo by A. Irmer.

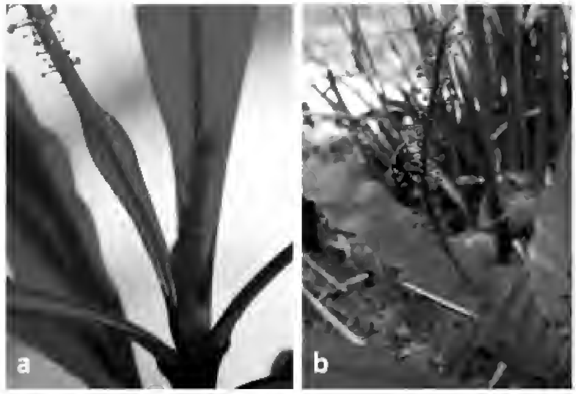

Figure 4: The development of the leaf base of the carnivorous organ of *Triphyophyllum peltatum*. Photo left by A. Irmer; right by K. Rembold.

The method presented here permits production of rooted young plants of *Triphyophyllum peltatum* for cultivation in a greenhouse and without loss of plant material: Non-rooted shoots were not lost but could be further cultivated under sterile conditions.

Formation of Glandular Leaves

The *Triphyophyllum* plant in the Botanical Gardens of Bonn developed three carnivorous leaves in July 2006 (see Front Cover). In December 2007, one of the previously sterile young plants in Würzburg likewise started developing two carnivorous glandular leaves followed by a period of rapid growth, leaf enlargement and, surprisingly, formation of more carnivorous organs after 6 months (up to five on one plant). In May 2008, two more plants at the Botanical Garden of Würzburg formed glandular leaves, too.

All glandular leaves observed at the Botanical Gardens of Bonn and Würzburg showed the typical reversely circinate unfolding (Green *et al.* 1979), similar to that of *Drosophyllum* (see Figure 3). During this unfolding process, all three types of glands – big and stalked, small and stalked, and sessile (Green *et al.* 1979) – were developed in parallel on the extended midrib. Each carnivorous organ developed a broadened leaf base (see Figure 4), while the midrib was unfolding.

The size of the broadened leaf base differed from organ to organ, ranging between 2 and 8 cm in length and 0.5 and nearly 2 cm in width. The green leaf base and the glandular parts showed a reciprocal size ratio: the bigger the leaf base, the smaller the glandular part. The tip of fully unfolded and mature carnivorous organs was formed by a stalked gland, *ca.* 1.5 to 2 times bigger than the size of other glands (see Figure 5). In some cases, the tip was bifurcated looking like a two-toothed fork. Such a modification had already been observed earlier (Schmid 1964). It is reminiscent of the subsequently formed hooked leaves of *Triphyophyllum*. The mature carnivorous organs remained erect and survived 3–4 weeks, and then they died-off rapidly and were shed immediately.

From the first fully developed gland on, the carnivorous organs secreted mucilage and captured small insects – like sciarids and chironomids – or spiders. The mucilage is known to contain digestive enzymes typical of carnivorous plants (Green *et al.* 1979; Bringmann & Rischer 2001); and it had been shown that the glandular leaves actively take up the amino acid L-alanine (Bringmann *et al.* 1996). The carnivorous glandular leaves of *Triphyophyllum* are considered as passive flypaper

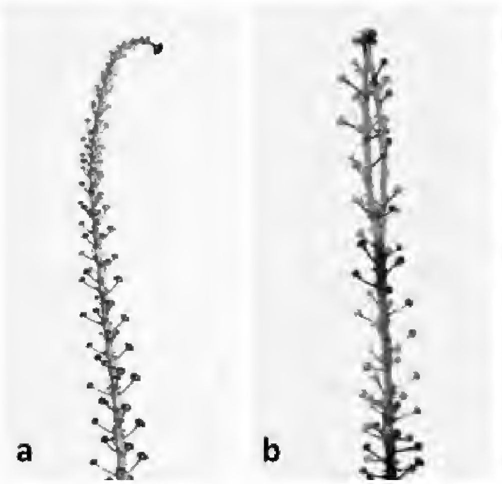

Figure 5: The apices of glandular leaves of *Triphyophyllum peltatum* showing the big tip gland (a) and a bifurcated tip (b). Photo (a) by A. Irmer; (b) by K. Rembold.

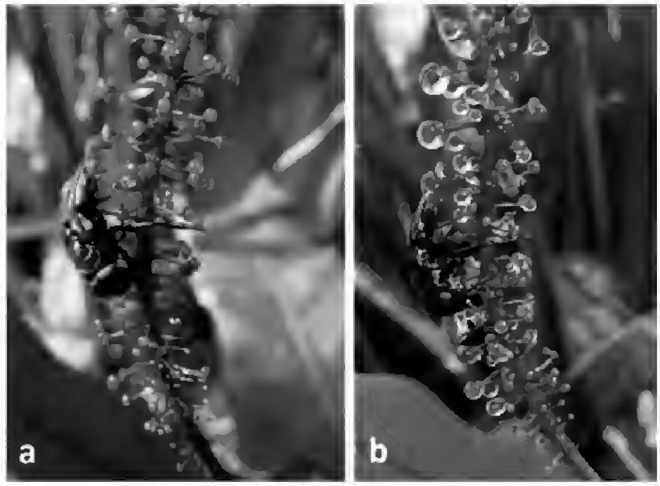

Figure 6: Glandular leaf of *Triphyophyllum peltatum*. On July 17, 2006, 6:00 pm: glands with little mucilage (a). On July 18, 2006, 9:30 am: glands were covered abundantly with secretion (b). Photos by K. Rembold.

traps (Marburger 1974; Green *et al.* 1979; Marburger 1979). Although the carnivory of *Triphyophyllum* is proven, but it has never been investigated experimentally whether the stalked glands show any movement when stimulated by prey.

The Flypaper Traps of *Triphyophyllum* are Passive

A blowfly (Calliphoridae) was placed alive on a two-week old glandular leaf of the *Triphyophyllum* specimen in the Botanical Gardens of Bonn in order to test whether the glandular organs of *T. peltatum* are passive flypaper traps or if they are actively capable of tentacle or leaf movements, and to test the trap efficiency. The insect adhered to the mucilage secreted by the stalked glands but was able to escape after *ca.* 30 minutes. The successful escape of the fly suggests that the natural prey spectrum of *T. peltatum* might consist of smaller or weaker animals (Green *et al.* 1979; Bringmann *et al.* 2001; McPherson 2008). The fly was incapable of flying because it was covered in mucilage and remained trapped after a second placement on the leaf.

The carnivorous organ with the prey was constantly monitored and photos were taken in intervals during July 17 and 18, 2006. During this time, tentacle or leaf movements were not noticed. Even during the following days neither the leaf lamina nor the tentacles changed their orientation. This confirms that the glandular leaves of *Triphyophyllum peltatum* act as passive flypaper traps. A discoloration of the stalked glands after contact with the prey, as reported by Marburger (1979), was not observed.

The amount of secreted mucilage however, was notably altered in the course of the days (see Figure 6), and decreased towards the evening. In the mornings, some drops on adjacent tentacles were found to have converged as a consequence of increased secretion.

Interestingly, *Triphyophyllum peltatum* produced again lanceolate leaves, both in the Botanical Gardens of Bonn and Würzburg after the carnivorous phase. Obviously, the succession of the juvenile stage followed by a carnivorous phase prior to the development of the adult liana is not obligatory. It had been observed earlier that *T. peltatum* can also progress from the juvenile directly to the adult liana stage without forming any carnivorous organs (Bringmann *et al.* 2002). Adult plants in nature are able to produce carnivorous leaves on climbing stems (McPherson 2008).

In summary it can be stated that *Triphyophyllum* shows remarkable flexibility in terms of its morphological development, the determining factors of which still remain elusive.

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New Cultivars

Keywords : cultivar: *Dionaea* 'Mirror', *Sarracenia* 'Mountain Splendor', *Pinguicula* Harry Tongue Group, *Pinguicula* 'Jannes', *Pinguicula* 'Bettie'

Dionaea 'Mirror'

Submitted: 9 June 2010

A couple of years ago, Drosera VZW, the Belgian carnivorous plants society, organized a trip to Carniflora, a CP producing company in Aalsmeer, the Netherlands. Since most of my *Dionaea*'s died after a terrible winter (I kept them outside, they normally survive most of our wet winters), I decided to give them another try in May 2007 and bought several young plants, seemingly looking quite the same. Back home, after having a closer look at my purchase, I discovered a somewhat small plant with distinctively different leaves; they were "winged".

During its maturation, I discovered the variability of this peculiar plant. The variability ranges from leaves with normal traps to leaves with double traps (see Figure 1), and everything in between (little "wings" or even "cups" on each side of the trap (see Figure 2). Double traps are formed in the beginning and the end of a growing season.

One year later, Dirk De Troyer, the treasurer of our CP society, came to visit my collection and was amazed by this special Venus Flytrap. Together, we decided to name it 'Mirror', after the striking symmetry of the double traps. The second trap produced on the back of the normal one is not active.

Dionaea 'Mirror' has no other distinctive characteristics besides its traps. It grows and flowers quite normally. I propagated many plants over time, but always in a vegetative way.

The standard pictures first appeared in Drosera VZW Nieuwsblad 19 (2), 2008. Reproduced with permission.

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Figure 1: Sideview on a *Dionaea* 'Mirror' double trap.

Figure 2: Back view on a *Dionaea* 'Mirror' trap with "cups" on each lobe of the trap.

Submitted: 17 June 2010

This plant was an intentional hybrid created by me in May of 1999, and is a selection of *Sarracenia oreophila* × *Sarracenia rubra* subsp. *jonesii*. *S. oreophila* was the receptive flower and seed producer.

On 28 May 2007, I coined the cultivar epithet 'Mountain Splendor' for this delightful plant. Both parents of this cultivar are of mountain origins in Alabama (for *S. oreophila*) and North Carolina (for *S. rubra* subsp. *jonesii*). Its subtle colorations, profusion of flowers, and stately stature truly make it a splendor to behold.

In the early season, flowers and pitchers open at nearly the same time. Depending on rhizome size, a 1.2-cm division can have about 3 crowns, and will produce 5-7 pitchers ranging in size from 4 to 8 cm. Pitchers are green with golden hues interlaced with red veins. This first crop of leaves tend to have the robust round appearance of *S. oreophila*, with a slight flaring of the lids as seen in the *S. rubra* subsp. *jonesii* parent. Production of these pitchers continues usually to the end of June depending on temperatures. Taller leaves often become floppy, but are often replaced with new ones. Growth slows some in the mid-summer heat, but resumes again in the cooler temperatures of late August (in Oregon). This next set of pitchers are usually shorter in stature (4.7 cm or less), have heavier red veining, and darken as the weather

Figure 3: *Sarracenia* 'Mountain Splendor' (center) growing with *Sarracenia oreophila* (plant to the left) and *Sarracenia rubra* subsp. *jonesii* (dark red flowers to the lower left). Photograph by Jeff Dallas.

cools in late September similar to the *S. rubra* subsp. *jonesii* parent. Late summer and fall also brings production of recurved phyllodia similar in appearance to *S. oreophila*, but much smaller.

Flowers on this plant are prolific and showy. A roughly 3-year-old plant from a 3- or 4-crown division can produce 12 to 13 flowers. Petals range in color from peach colored to lipstick red, and sepals tend to be two-tone red and gold before petal drop. Flowers are roughly 0.8 cm across – about half-way in size between the parents. They are strongly scented with a sweet almost Easter Lily-like scent. The plant fairly consistently produces open pitchers and flowers simultaneously, increasing the overall aesthetics.

A couple of other features are of note with this plant. One is its cold hardiness. Since both parents are of mountain origin (USDA zone 7a), it is remarkably cold hardy. Our plants have survived short periods of -5°C with only a tarp for protection. The other feature of note is the vigorousness of the growth. This plant consistently doubles the size of its rhizome mass each season. It also lends itself to easy division for propagation due to fast growth of crowns.

The plants were planted together in 2008, one each of the parent clones and a 'Mountain Splendor' (see Figure 3). The *S. oreophila* and 'Mountain Splendor' were similar-sized rhizomes. The *S. rubra* subsp. *jonesii* was a two-crown division. Flowers of all three can be seen, and the dramatic growth rate of the 'Mountain Splendor'.

Propagation is by vegetative division. Specimens are available periodically through Sarracenia Northwest at: http://www.cobraplant.com

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Description of *Pinguicula* Harry Tongue Group (*debbertiana* × *cyclosecta*)

Submitted: 27 June 2010

The Group consists of perennial plants with short and unbranched shoots. Members of this Group form a flat rosette, with short, white, unbranched roots. The affinities to *P. cyclosecta* and *P. debbertiana* are well recognizable. The winter leaves are blunt, spatulate and with weak hairiness, forming rosettes 3.5 cm in diameter of about 50 leaves. In mid-March the summer rosettes appear which are intermediate between *P. debbertiana* and *P. cyclosecta*, but slightly closer to the latter. The summer leaves are glandular hairy and a little bit thinner than the winter leaves. The coloration varies between orange-pink and purple.

Until now two different cultivars belonging to this Group were identified, both with very similar leaves, but with different flowers.

Pinguicula debbertiana × *cyclosecta* clone I (=*Pinguicula* 'Jannes')

The flower of *P.* 'Jannes' is more similar to *P. cyclosecta* (see Figure 4). The upper corolla lip consists of two round lobes; the lower lip has three round lobes that overlap partially. The color is identical to *P. cyclosecta*, perhaps a little more purple. The veins are darker and go from the throat up to the tips of the lobes and can also be seen on the spur. The throat has a white, somewhat greenish coloration and has some veins. The typical yellow hairs of *P. debbertiana* are present, but not as clearly distinct as in this species.

Figure 4: Comparison of *Pinguicula cyclosecta* (left), *P. debbertiana* (right), *P.* 'Jannes' (middle left), and *P.* 'Bettie' (middle right). Reproduced with permission from Das Taublatt, vol. 2009/2, p. 8.

Pinguicula debbertiana × *cyclosecta* clone II (=*Pinguicula* 'Bettie')

The flower of *P.* 'Bettie' is quite different from *P.* 'Jannes' (see Figure 4). The coloration is paler and the corolla lobes are longer, with rounded edges. They are narrower and do not overlap. In the place of the yellow spot of *P. debbertiana* there is a white one, but with no or very weak hairiness.

Reference

Weinberger, C. 2009. *Pinguicula debbertiana* × *cyclosecta* - Ein neuer Kulturhybrid. Das Taublatt 2009/2: 5-8.

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Terahertz and Infrared Spectra of Plumbagin, Juglone, and Menadione

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Keywords: FTIR, THz-TDS, 1,4-naphthoquinone derivatives, plumbagin, juglone, menadione.

Abstract

Three naphthoquinone derivatives (plumbagin, juglone, and menadione) have been reported with antibacterial, antifungal, and antiviral properties and could potentially be used as anticancer agents because they can provoke apoptosis. However, they are also strong oxidants and cause cytotoxicity and even necrosis, so they are only limited to experimental chemotherapeutic use. In order to understand their physical chemical properties, we used both Fourier Transform Infrared Spectroscopy (FTIR) and Terahertz Time-Domain Spectroscopy (THz-TDS) to study their absorption spectra in wave number ranges of 400~4000 cm^{-1} and 6.6 ~ 92.4 cm^{-1}. We also analyzed their characteristic absorption peaks, and assigned spectra peaks in IR range to their molecular structures. These data will be very useful in future studies of their pharmaceutical mechanisms.

Introduction

Some carnivorous plants have been used as herbal medicines to cure diseases, and their therapeutic effects appear to be attributed to some naphthoquinone derivatives in the medicines. For example, a patented alternative herbal medicine Carnivora that is made from venus-flytrap *Dionaea* has been reported with immodulatory, tumorcidal, antimicrobial, antiviral, antiparasitic and antibiotic properties; and its main components include plumbagin (5-hydroxy-2-methyl-1,4-naphthoquinone) and other 1,4-naphthoquinone derivates (Keller 2001).

Plumbagin is also commonly found in *Plumbago*, *Nepenthes*, *Drosera*, and a few other plants (Jayaram & Prasad 2005; Kapadia *et al.* 2005; Likhitwitayawuid *et al.* 1998). Plumbagin and two other naphthoquinone derivates, juglone (5-hydroxy-1,4-naphthoquinone) and menadione (2-Methyl-1,4-naphthoquinone, also called Vitamin K3), have been reported with antitumor properties, since they can provoke apoptosis (Guan *et al.* 2004; Inbaraj & Chignell 2004; Parimala & Sachdanandam 1993; Sugie *et al.* 1998). However, they are also strong oxidants, leading to the formation of superoxide or oxidizing glutathione (an antioxidant, detoxifier, and immune defense system) in cells, and cause cytotoxicity and even necrosis (Inbaraj & Chignell 2004). In order to understand their chemotherapeutic mechanism before safely using them as anticancer agents, we began to use THz–Time Domain Spectroscopy (THz-TDS) to study plumbagin, juglone, and menadione; and use Fourier Transform Infrared Spectroscopy (FTIR) to reveal more physical chemical properties of these molecules. Our results may be further used in monitoring intermolecular reactions of these naphthoquinone derivatives with glutathione and other biomolecules in future.

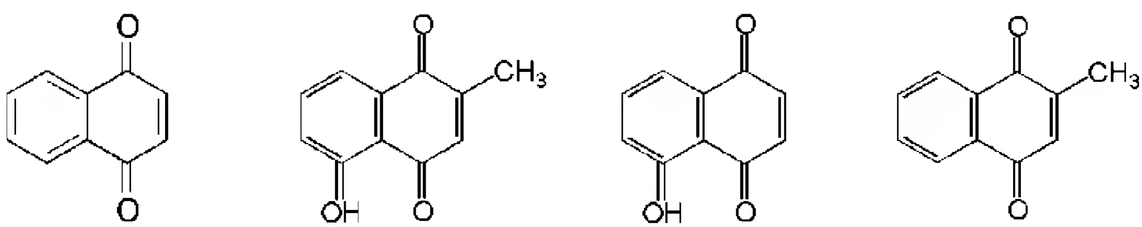
IR Spectroscopy is widely used to identify chemical compounds, because almost all organic compounds have absorption spectra in the infrared portion. IR absorption spectra can be used to distinguish functional groups of molecules and thus to determine their molecular structures (Lu & Deng 1989). IR Spectroscopy has also been used to study plumbagin (Sajan *et al.* 2005). With FTIR, we have successfully obtained the absorption spectra of plumbagin, juglone, and menadione, in the mid-wavelength IR range between 400~4000 cm^{-1}, so we compare our results with previous studies, in this paper.

THz wavelength falls within 0.1~10 THz (wave number 3.3 cm^{-1}~333 cm^{-1}), between micro-waves and infrared. THz-TDS is a newly developed physical research approach, and it is highly sensitive, stable, fast, and non-ionizing and can safely penetrate through material. Thus THz spectroscopy has been quickly introduced to examine biological tissues (Mickan & Menikh 2002) and biomolecules, such as peptides, DNA, RNA, amino acids (*e.g.*, Wang *et al.* 2009), proteins, and other biomolecules (*e.g.*, Wang *et al.* 2005). Yet, it provides access to THz region that is difficult to reach by conventional means, and can be used to supplement Fourier Transform Infrared Spectroscopy (FTIR). With THz-TDS, we have successfully obtained THz spectra of plumbagin, juglone, and menadione, in the range 6.6~92.4 cm^{-1} (0.2~2.6 THz). In this paper we will present our results and discuss the possible correlations between specific absorption peaks and molecular structures, using both FTIR and THz-TDS approaches.

Material and Methods

All samples (see Figure 1) were obtained from Sigma-Aldrich Chemical Co. (USA), plumbagin (98%) in orange yellow polycrystalline grains, juglone (97%) in yellow needles, and menadione (98%) in yellow polycrystalline powder. For FTIR the samples were mixed with potassium bromide in a mass ratio 1:10, while samples for THz-TDS were mixed in a mass ratio 2:1 with polyethylene powder that is nearly transparent for THz wave. Then they were pressed under a pressure of 1500 kg and 2000 kg respectively into disks 1.3 mm in diameter and 1 mm in thickness.

Infrared spectra were recorded with Equinox 55 FTIR spectrometer of Bruker (Germany). The resolution is 4 cm^{-1} and the bandwidth is 4000–400 cm^{-1}. The THz-TDS system was set up as illustrated in Figure 2. A mode-locked Mai-Tai Laser of Spectra-Physics (USA) was used to generate laser pulse. The system has a sample box that is purged with dry nitrogen to keep the humidity less than 2%, to minimize the vapor effects and thus enhance the signal-to-noise ratio (SNR). Within the sample box are an InAs wafer with <100> orientation to emit THz beam and a ZnTe wafer with <110> orientation to receive signals. Sample signals were yielded when a THz beam passed through a sample between the two wafers, and reference signals were received when the THz beam passed



Naphthoquinone Plumbagin Juglone Menadione

Figure 1: Structural formula of naphthoquinone (1,4-naphthoquinone), plumbagin (5-hydroxy-2-methyl-1,4-naphthoquinone), juglone (5-hydroxy-1,4-naphthoquinone), and menadione (2-Methyl-1,4-naphthoquinone).

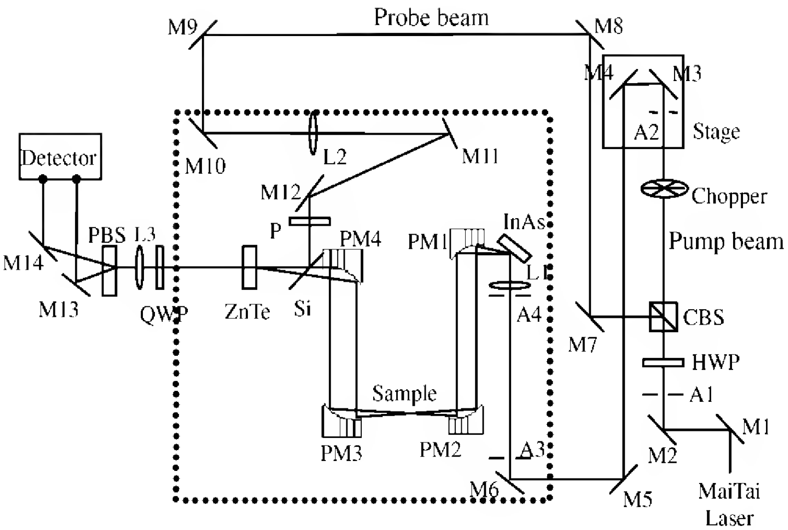


Figure 2: Diagram of the THz-TDS system

through the box without sample. Both reference and sample signals were compared and calculated automatically to plot spectra with reflection index and absorption coefficient.

Results

Figure 3 shows the absorption spectra of plumbagin, juglone, and menadione in the IR range between 400~4000 cm^{-1} with many characteristic peaks that can be easily assigned to their functional groups or structures (Table 1), based on previous studies (Chawla *et al.* 1995; Globus *et al.* 2004; Lu & Deng 1989). For example, absorption peaks of C=C are found in the range 1690-1635 cm^{-1} (Lu & Deng 1989).

The THz absorption spectra of plumbagin, juglone, and menadione were obtained, with a validate range between 0.2~2.6 THz (see Figure 4), and their absorption peaks are presented in Table 2. Although they all belong to 1,4-naphthoquinones derivatives, their THz spectra obviously have characteristic absorption peaks, and thus can be used as molecular fingerprints in identification.

Discussion

For IR spectra, we will mainly discuss the characteristic absorption peaks of three functional groups (C=O, OH, and CH_3) of plumbagin, juglone, and menadione, in following five aspects:

Table 1. Assignments of functional groups and structures of plumbagin, juglone, and menadione.

	Plumbagin cm^{-1}	Juglone cm^{-1}	Menadione cm^{-1}
V(C=O)	1664.16 1644.09	1665.41 1643.35	1665.07 1622.22
V(OH)	3436.69	3435.88	
V(CH_3)	1365.14		1379.31
δ (ring)	1608.69	1600.24	1593.01
V(CH) on the ring	2964.24	3071.41	3068.33 2957.74
β (CH)	1303.59 1258.75	1337.13 1290.49	1327.57 1301.10
γ (CH) on the ring	835.93 753.22	858.11	779.89

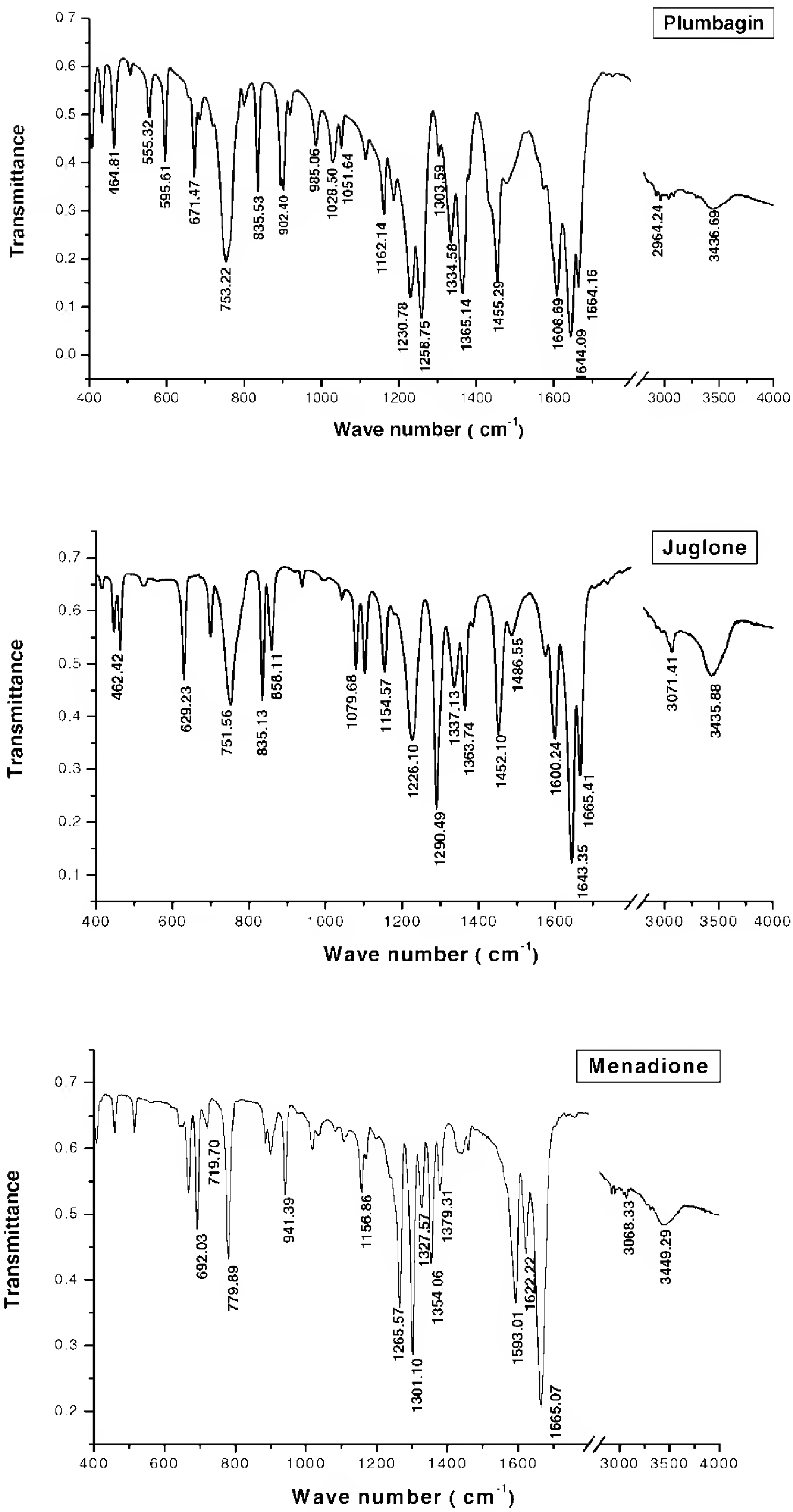


Figure 3: IR Absorption spectra of plumbagin, juglone, and menadione.

1) The hydroxyl group (OH) of juglone and plumbagin occurs at 3435.88 cm^{-1} and 3436.69 cm^{-1} respectively (Table 1), closely matching with the OH peak (3412 cm^{-1}) of plumbagin reported by Sajan *et al.* (2005).

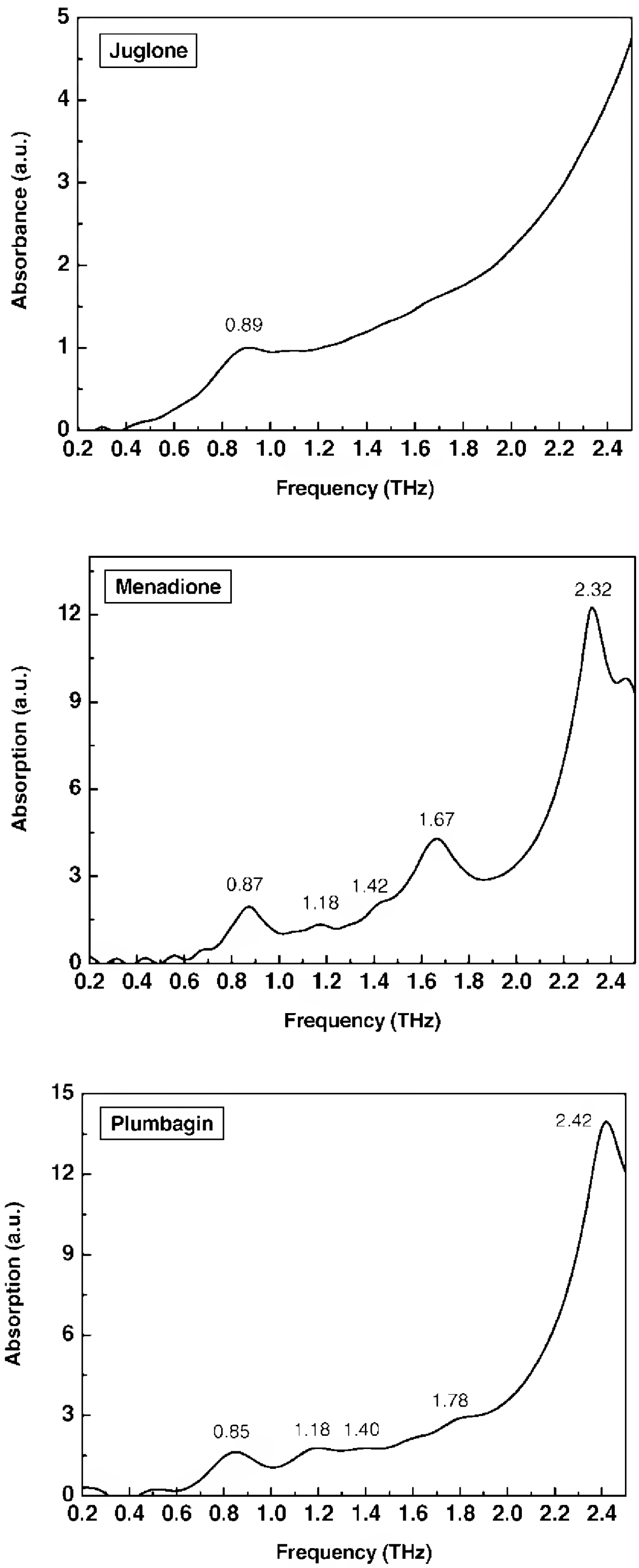


Figure 4: THz absorption spectra of plumbagin, juglone, and menadione.

2) Different from juglone, the IR spectra of menadione and plumbagin have a strong absorption peak between 1360 cm^{-1}~1380 cm^{-1}, due to existence of methyl group (CH_3). In other words, the existence of peaks at 1379.31 cm^{-1} and 1365.14 cm^{-1} indicates the existence of the methyl group (CH_3) on the aromatic ring (Lu & Deng 1989; Sajan *et al.* 2005).

3) Commonly, a carbonyl group (C=O) of quinones has 1-2 characteristic absorption peaks between 1690 cm^{-1} and 1635 cm^{-1}. When a carbonyl group (C=O) has two peaks, the higher frequency peak would be normally stronger than the lower frequency peak. However, when there is a hydroxyl group (OH), the higher frequency peak would become weaker (Lu & Deng 1989). In our results, plumbagin, juglone, and menadione all have two peaks within the frequency range, and the peak strengths really concur with the aforementioned statements: the 1665.07 cm^{-1} peak of menadione is stronger than its 1622.22 cm^{-1} peak; and the higher frequency peak of juglone and plumbagin (both have a hydroxyl group) is weaker than their lower frequency peak (see Figure 3).

4) When a carbonyl group (C=O) has two peaks, and if there is a hydroxyl group on the aromatic ring, the frequency of the lower frequency peak would be decreased (Lu & Deng 1989). Both plumbagin and Juglone have a hydroxyl group (OH), however, our results show that their lower frequency peaks have higher frequency at 1644.09 and 1643.35 cm^{-1} respectively than the 1622.22 cm^{-1} peak of menadione that lacks a hydroxyl group (Table 1). These results are very different from previous conclusions and should be further studied.

5) Interestingly, the absorption spectrum of plumbagin reported by Sajan *et al.* (2005) showed only one absorption peak at 1663.69 cm^{-1}, but now we have found two peaks at 1664.16 cm^{-1} and 1644.09 cm^{-1} for carbonyl group (Table 1).

Table 2. THz Absorption peaks of plumbagin, juglone, and menadione (Frequency unit: THz).					
Plumbagin	0.85	1.18	1.40	1.78	2.43
Juglone	0.89				
Menadione	0.87	1.18	1.42	1.67	2.32

In Sajan *et al.* (2005) the peak around 1644 cm^{-1} could be masked by a very strong peak at 1608.54 cm^{-1} of the δ ring, while in our spectrum the δ ring peak at 1608.69 cm^{-1} is much weaker and the 1644 cm^{-1} peak is the strongest (see Figure 3). Sajan *et al.* (2005) also obtained plumbagin from the same company, but with 99.9% purity. Maybe the higher purity strengthened the absorption peak of the δ ring.

The THz absorption peaks of large molecules are commonly interpreted as collective rotational and vibrational modes of the whole molecules, determined by their molecular configuration and conformation (Siegel 2000; Mickan & Zhang 2003), rather than referring to specific functional groups/structures. However, since all three 1,4-naphthoquinone derivatives have most parts identical to each other, their common absorption peaks should be determined by their basic, common molecular structures, while their different peaks could be correlated with their specific functional groups. On this basis, we have comparatively analyzed the THz spectra of plumbagin, juglone, and menadione, and found some correlations between absorption peaks and molecular structure and functional groups, in following three aspects:

1) Plumbagin, juglone, and menadione all have a basic 1,4-naphthoguinone structure (see Figure 1), and all have an absorption peak between 0.85~0.89 THz (see Figure 4, Table 2). This peak appears to represent a rotational and vibrational mode that is determined by the basic molecular structure.

2) Plumbagin and juglone are almost identical (see Figure 1), but plumbagin has a methyl group (CH_3), and its THz spectrum has four more absorption peaks (see Figure 4, Table 2). Therefore, the four additional peaks appear to be correlated to the methyl group. The above hypothesis has been supported by menadione that also has a have a methyl group (CH_3) at the same position (see Figure 1), and menadione also has four additional absorption peaks. The four additional peaks of both plumbagin and menadione are very close in terms of frequency and strength (see Figure 4, Table 2). Therefore, increased absorption peaks appear to be related to the addition of the methyl group (CH_3) that could cause dynamic changes of the molecules; and the same correlation is also found in our study of amino acids (Wang *et al.* 2009). The addition of a methyl group to the 1,4-naphthoquino structure could increase the intermolecular hydrogen bond vibrations, as Fischer *et al.* (2002) suggested based on their study of THz spectra of DNA bases, and thus cause the increase of vibrational modes that are represented by absorption peaks.

3) Comparing the THz spectra between plumbagin and juglone, both have a hydroxyl (OH) group (see Figure 1), plumbagin has five absorption peaks, while juglone has only one absorption peak (see Figure 4, Table 2). Therefore, the hydroxyl group itself appears not a factor causing the different absorption peaks. On the other hand, menadione does not have a hydroxyl group, but it also has five absorption peaks. So the presence or absence of hydroxyl group would not affect the absorption spectra in this THz range.

In short, many of results of these FTIR and THz spectra of plumbagin, juglone, and menadione, are reported for the first time. These important data can be further used to study the pharmaceutical mechanism of these 1,4-naphthoquinone derivatives and their interactions with biomolecules.

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Nepenthes palawanensis:

Another new species of giant pitcher plant from the Philippines

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Keywords: *Nepenthes palwanensis*, Sultan Peak, Palawan, Philippines.

Following the discovery of *Nepenthes attenboroughii* on Mount Victoria, I returned to Palawan in January 2010 to explore another mountain called Sultan Peak with a Filipino botanist friend. As mentioned in my article on *Nepenthes attenboroughii* one year ago, the Philippine island of Palawan is of extreme botanical interest because it is a hotspot of diversity located close to the great island of Borneo, but it has remained relatively little explored, especially in terms of carnivorous plants.

After spending one week to receive permission from the provincial mayor and local authorities, I was fortunate to travel to the base of Sultan Peak and begin a climb to the summit of the mountain. Sultan Peak is located nearby Mount Victoria, but is separated by a large valley several kilometers broad. The summit is of a comparable altitude but it is ecologically isolated and so a possible home for distinct, but related highland *Nepenthes* flora. I arrived at the base of Sultan Peak on January 17th, having previously found and engaged three hunters who would act as guides, and purchased food and provisions. The guides live in a wooden shack near to the base of Sultan Peak, however repeatedly said that, to the best of their knowledge, no person had previously climbed to the summit of the mountain. They agreed to help me climb as far up the unknown slopes as possible, but repeatedly exclaimed that they did not know whether the summit was within reach.

Our little group left on January 18th, and trekking through the lowlands we passed several hunting parties searching for pigs. Each hunting group had long wooden spears with sharpened metal points and hunting dogs. The climb up Sultan Peak was not difficult and a path existed for several kilometers up the lower slopes, but swiftly evaporated in the mayhem of rainforest vegetation. We

Figure 1: Stewart McPherson enjoying large *Nepenthes palwanensis* pitchers, Sultan Peak, Palawan, Philippines.

could proceed only by machetteing a path forward or by following the courses of streams. After two days trekking, we reached a ledge close to a 30-m waterfall and beheld a glorious view of Mount Victoria in the distance. This was as far as the guides had been before, and since the waterfall was nameless, we decided to call it Sultan Falls. Two of the guides looked ahead for the best direction to continue, while I helped establish our camp for the night.

The following morning we continued our climb, scrambling up a steep water course and climbing up several abrupt, near vertical ledges. After several hours we passed through bamboo forest, then upper montane scrub, and then finally we reached the summit of a ridge line a few hundred metres below the mountain top. Exactly as on Mount Victoria, as I stepped out from the bushes and small trees into open montane heath, the abrupt vegetation change brought a population of a magnificent giant *Nepenthes* plants. After studying the *Nepenthes* for a few minutes, it was apparent that the find represented a new species, although one very closely related to *N. attenboroughii.*

The *Nepenthes* of Sultan Peak bore spectacular ovate, reddish pitchers lined with short hairs (see Back Cover). The traps are truly gigantic, I found several pitchers exceeding 35 cm in length, and so large that I could place my entire hand and part of my forearm inside the great traps (see Figure 1). Interestingly, all of the pitchers I observed were lower ones. Many highland *Nepenthes* of the Philippines are known to only produce lower pitchers (*e.g. N. hamiguitanensis*), however, this trait in this new taxon was in stark contrast to *N. attenboroughii*, which produces upper pitchers from a very early age, and all mature plants consist entirely of upper traps. Other subtle differences could be identified in the leaf structure, pitcher lid, and various other characteristics.

Continued exploration of the summit of Sultan Peak revealed that all populations of the *Nepenthes* occurred in direct sunlight amongst windswept, stunted, upper montane shrubs and scrub 1 m tall or so. Most of the aged, mature plants had formed a rigid, upright or scrambling stem up to 1.5 m long and had a growing habit almost identical to *N. attenboroughii.* With no water source on the summit, and no rivers visible on the upper slopes, we were forced to begin our descent in the early afternoon and began trekking down the ridge top, past the scars of gigantic landslides. The following day, we returned back to civilisation, and shared all our findings with friends at the Palawan State University. We jointly decided that the plant would be named *Nepenthes palawanensis*, since its pitchers are larger than *N. attenboroughii* and all other *Nepenthes* of Palawan, and so a fitting tribute to that beautiful Philippine isle.

An extensive account of the morphology of *Nepenthes palawanensis* is presented in Stewart McPherson's new, two volume work *Carnivorous Plants and their Habitats*, which examines all carnivorous plant genera in the wild (see www.redfernnaturalhistory.com for more information and also for videos and photos of *Nepenthes palawanensis*).

Noteworthy Collections: Florida

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Drosera filiformis Raf. × *tracyi* Macf. (Droseraceae)—southeastern Washington County, Florida, elevation 20 m, 29 May 2010. Plants were found flowering on the wet borders of a low, sandy lake, with *Drosera filiformis* Raf. and *Drosera tracyi* Macf.

Previous Knowledge

This represents the first collection of this plant in the wild. One parent plant, *Drosera tracyi*, occurs along the Gulf Coast, from Louisiana (historical only—the plant has not been collected for at least 30 years) through Mississippi, Alabama, the panhandle of Florida, and into southwestern Georgia.

The other parent plant, *Drosera filiformis*, occurs in widely scattered locations along the Atlantic Coast, with records for Nova Scotia, Massachusetts, Rhode Island (probably extinct), Connecticut (historical only), New York, New Jersey, and Maryland, then after large range gaps the plant reappears in North Carolina and northwestern Florida. Reports from Delaware and South Carolina appear to be anecdotal. It has been collected from adjacent counties in West Virginia and Pennsylvania, but these plants are believed to be introduced. Both *Drosera filiformis* and *Drosera tracyi* have been introduced to other states by horticulturists, as well.

The populations of *Drosera filiformis* in Florida are of considerable interest; I have been studying these plants for several years, and a discussion of them will be published separately.

Significance

The only opportunity for natural overlap of the two parent species is in Florida (Bay and Washington Counties). A single location has been documented where both species occur together, but a 1990 herbarium specimen from this site indicates that there is "no sign of intergradation" (L.C. Anderson, 183046; FSU). In 2010 I visited this location, accompanied by Elizabeth M. Salvia. Despite careful searches only *Drosera filiformis* was observed; no *Drosera tracyi* or hybrids were detected.

In 2008-2009, a number of carnivorous plant enthusiasts (Makoto Honda, Jim Miller, Randy Zerr) reported a site where both species occur, and where hybridization was reportedly occurring. In 2010 I visited this location with Brian Barnes, Jim Miller, Elizabeth Salvia, and Randy Zerr, and observed both parent species. Furthermore, a hybrid swarm was visible with at least hundreds of plants present. The full extent of the population could not be assessed because our team was driven from the site by electrical storms.

The hybrid nature of the plants was evident because the plants were very large (leaf lengths approximately 25-28 cm; inflorescence lengths approximately 43-50 cm). This is larger than is typical for *Drosera filiformis*, but is more typical for *Drosera tracyi*. Meanwhile, the gland tentacles and leaf blades were suffused with pale red pigmentation. This pigmentation is absent in *Drosera tracyi*, while it is darker red in *Drosera filiformis*. The hybrid (involving Floridian *Drosera filiformis*) has been made in cultivation by Brian Barnes, and has similar characteristics.

The hybrids were producing large numbers of seeds, although many of the seeds had aborted and were only approximately 1/4–1/3 normal size. Similarly, a cultivar (*Drosera* 'California Sunset') was made by a horticulturist in 1973, and is demonstrably fertile.

Voucher specimens have been submitted to the University of California, Davis (DAV), #BR100502, and Florida State University, Tallahassee (FSU), #BR100503. Color photographs from the 2010 trip can be seen at http://www.sarracenia.com.

News and Views

John Brittnacher (john@carnivorousplants.org) writes: Peter D'Amato in his very excellent article about Francis Ernst Lloyd in the March 2010 issue of CPN doesn't mention that Lloyds's classic book, The Carnivorous Plants, is back in print. There are several versions: Lloyd Press, hardcover (372 pages, 2008, ISBN 1443728918) and paperback (368 pages, 2007, ISBN 1406757020); and Dover Publications, paperback (352 pages, 2007, ISBN 0486233219).

Bob Harrell (bobhnc@gmail.com) writes: I would to thank Peter D'Amato for his very entertaining article about Francis Ernest Lloyd, "Lloydie" (CPN 39(2): 47-49). As one who spent a lot of time in his youth in libraries looking at this book, I really enjoyed the biography reading about Dr. Lloyd. I also liked the picture of the four gentlemen in suits holding up a *Nepenthes*; gatherings seem more informal these days. Dr. Lloyd's book is scientific and certainly beyond my abilities at the time to understand a lot of it, but those tiny black and white pictures sure fired the imagination. Peter points out how little information was available a generation ago, especially compared to the numerous wonderful books and countless websites devoted to the plants. The easy availability of carnivorous plants is another huge change. Twenty years ago it was almost impossible to find more than a few common species. My own modest collection now is far beyond anything I ever imagined growing up. I hope it will be possible to have more articles about some of the carnivorous plant pioneers. It would be nice to know more about those who made our current wealth of plants and knowledge possible.

Barry Rice (barry@sarracenia.com) writes: In late March 2010 I was forwarded very interesting email, but unfortunately in this context, "interesting" is a euphemism for frustrating and disheartening. The author of the open letter was Anne E. Morkill, a US Fish and Wildlife Service refuge manager for the Florida Keys National Wildlife Refuges Complex. It was addressed to both the chairman and the president of the American Orchid Society (AOS).

The cause for this letter was a booklet printed by the Key West Orchid Society. This booklet contained specific instructions on where to travel in the National Key Deer Refuge to find and collect orchids. In their letter, the US Fish & Wildlife Service reminded the AOS that the collection of any plant is prohibited on national wildlife refuges. Furthermore, the refuge locations carefully described in the booklet were closed to public entry precisely because they contained plant species which were rare and vulnerable to poaching threats.

I think it is particularly chilling that in one line of the booklet, the author encourages the illegal collector to have a conservation ethic: "Be a responsible collector, being careful not to destroy what you leave behind…." Is conservation so backwards in the orchid collecting world that it is considered important to remind people not to destroy all the plants that are not collected? (This practice was done by plant collectors during the Victorian era in order to give heightened value to the few plants that were collected.) I hope not, but the contributor to the Key West Orchid Society seems to think so.

This letter was given wide circulation throughout Florida, and is no doubt a huge embarrassment to the AOS. Unfortunately, because of the close overlap in orchid cultivation and carnivorous plant cultivation, this kind of regressive behavior reflects badly upon us all—don't expect a warm reception if you ask refuge managers in the Florida Keys for suggestions on where to find carnivorous plants!

Barry Rice (barry@sarracenia.com) writes about a mini-experiment he conducted on *Drosophyllum lusitanicum* (see Figure 1). "I grow *Drosophyllum* outside, and sometimes the wind knocks the seeds out of the flower capsules before I gather them. I lose most of my seeds this way. The last time I harvested seeds, I collected both open and closed fruit. The seeds from the open fruit were black and hard, but most of the seed from the greenish fruit ranged in color from pea green to light grey, and were still soft. As an experiment I tried to germinate them. My conditions for the experiment were not ideal (the pots were kept in conditions that were too wet), so I had low germination rates even with the black seeds. But after about four months I had observed germination with both the black and green seeds. Apparently, *Drosophyllum* seeds collected while still immature are at least partially viable. This fact is useful to me—in the future I know I can collect seeds from both mature and immature fruit. It also means that scientists and land managers tasked with sampling wild populations of *Drosophyllum* could collect seeds that are not optimally mature."

Figure 1: Immature *Drosophyllum lusitanicum* seed capsule (left) and mature seeds (right). Photos by Barry Rice.

Looking Back: CPN 25 years ago

Faith Campbell, Natural Resources Defense Council, Inc., wrote that carnivorous plants continue to receive a low priority from both governmental and non-governmental conservation agencies. She discussed the differing conservation approaches used by the U.S. Forest Service, Fish and Wildlife Service, Air Force, Congress, Florida state, The Nature Conservancy (TNC), and the International Union for Conservation of Nature and Natural Resources (IUCN). She concluded, "While it clearly would be inaccurate to say that nothing is being done to conserve America's carnivorous plant species, it remains true that the combined efforts are paltry compared to the need." (BZ)

Limited Edition Books

The last <u>first edition</u> copies of the following books by Stewart McPherson are available from www.redfernnaturalhistory.com.

Profits from **<u>all sales</u>** are donated to Meadowview Biological Research Station (www.pitcherplant.org) to support the conservation of carnivorous plant habitats. As of November 2009, **<u>US $5,500</u> has been raised and donated to this cause.**

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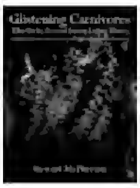

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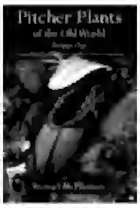

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