

CARNIVOROUS PLANT NEWSLETTER

Journal of the International Carnivorous Plant Society

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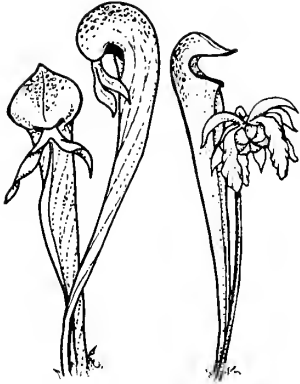
June 2006



CARNIVOROUS PLANT NEWSLETTER

Journal of the International
Carnivorous Plant Society
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Volume 35, Number 2
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Front Cover: *Darlingtonia californica* and *Pinguicula macroceras* subsp. *nortensis* in California. Read about *Darlingtonia* in Canada on page 36. Photograph by B. Rice.

Back Cover: The white-petalled taxon of *Drosera microphylla* in the wild. Note the vibrant red colouration of the plants. The plants are growing in moss-covered skeletal soil over granite, with *Borya* sp. and *D. glanduligera*. Note the white petals of the *D. microphylla* flowers are visible in bud, but no flowers were open that day due to cool and cloudy conditions. Photograph by Robert Gibson. Article on page 39.

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. Contributors should review the "Instructions to Authors" printed in the March issue of each year. 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 and back issues should be made to the ICPS in US funds. Dues for 2006 are \$25.

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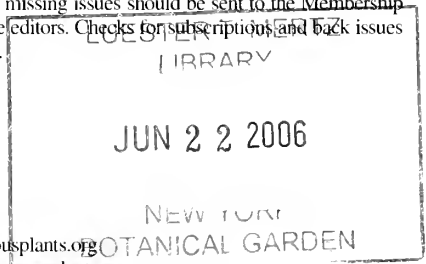
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CONTENTS

Seedbank	-35
<i>Darlingtonia californica</i> (Sarraceniaceae) and <i>Sarracenia purpurea</i> (Sarraceniaceae)—	
profiles of a refugee and a recluse in British Columbia	-36
Election announcement	-38
White-petalled <i>Drosera microphylla</i> Endl. from near Esperance, Western Australia	-39
<i>Heliamphora exappendiculata</i> , a clearly distinct species with unique characteristics	-43
Naphthoquinones content of some sundews (<i>Drosera</i> L)	-49
Plumbagin content in <i>Aldrovanda vesiculosa</i> shoots	-52
Looking back: CPN 25 years ago	-55
Book review	-56
Literature reviews	-57
Unexpected hybrids of spectacular bladderworts species	-59

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<i>Drosera auriculata</i> <i>D. binata</i> <i>D. binata</i> —Coromandel, NZ <i>D. burmannii</i> <i>D. capensis</i> 'Albino'—white flower <i>D. capensis</i> —narrow leaf <i>D. dielsiana</i> <i>D. filiformis</i> var. <i>filiformis</i> <i>D. glanduligera</i> <i>D. intermedia</i> —Cuba <i>D. intermedia</i> —New Jersey, USA <i>D. intermedia</i> —North Carolina, USA <i>D. intermedia</i> —Rhode Island, USA <i>D. intermedia</i> —Venezuela <i>D. peltata</i>	<i>D. rotundifolia</i> —Alaska, USA <i>D. rotundifolia</i> —Washington, USA <i>D. spatulata</i> <i>D. stolonifera</i> subsp. <i>porrecta</i> <i>D. tokaiensis</i> <i>Proboscidea louisianica</i> (noncarnivorous) <i>Sarracenia flava</i> <i>S. leucophylla</i> <i>S. oreophila</i> —ESA/CITES, USA sales only <i>S. purpurea</i> subsp. <i>purpurea</i> <i>S. purpurea</i> subsp. <i>venosa</i> <i>S. rubra</i> —infraspecific hybrid <i>S. rubra</i> subsp. <i>jonesii</i> —ESA/CITES, USA sales only
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Note: The seedbank address has changed! The new address is above!

This is a partial list of the seeds available. A complete list can be obtained online at the ICPS web site, <http://www.carnivorousplants.org/> or by sending a self-addressed, stamped (if USA), envelope to the seed bank address.

Seed packets are US\$1 each. Please include US\$3 postage and handling for each order. You may pay by cash, check, or money order in US\$. Many members pay with cash. Please make checks and money orders payable to "ICPS Seed Bank".

The seed bank is a members-only benefit. The quantity of seed available to each member is 1 packet of each variety per month and 40 packets total in any 12 month period. Please list alternative seed selections, as other orders will arrive before yours. If you have an e-mail address, please include it so we can correspond should any issues arise. Seeds purchased through the seed bank are intended for your personal use only and may not be sold.

You are encouraged to stock the seed bank with seed produced by cultivated plants. The ICPS policy on wild seed collection is on line at the ICPS web site. Cultivation-produced seeds of species protected by the US Endangered Species Act are distributed within the US only, and in accordance with the ICPS's US Fish & Wildlife Service permit.

Donate seed and get credit for free seed from the seed bank. Seeds of selected varieties are available free to teachers for use in the classroom and to scientists and conservation organizations. It is ICPS policy not to sell internationally seed of plants protected by CITES Appendix I or the US Endangered Species Act.

John Brittnacher, Manager • john@carnivorousplants.org

DARLINGTONIA CALIFORNICA (SARRACENIACEAE) AND
SARRACENIA PURPUREA (SARRACENIACEAE)—PROFILES OF A
REFUGEE AND A RECLUSE IN BRITISH COLUMBIA

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Keywords: observations, non-native species: *Darlingtonia californica*, *Sarracenia purpurea*, British Columbia (Canada).

Darlingtonia californica (Torrey) and *Sarracenia purpurea* subsp. *purpurea* (L.) are both hardy pitcher plants commonly found in carnivorous plant enthusiasts' collections. *Darlingtonia* is restricted to suitable habitats in a range extending from Oregon to northern California, but it is capable of surviving along the southwestern coast of British Columbia (B.C.), where the climate is virtually identical to its native range. *Sarracenia purpurea* subsp. *purpurea* is cold tolerant and could grow in any suitable location within B.C. However, only *Sarracenia purpurea* subsp. *purpurea* is naturally found in B.C., and even then only within a restricted area. Further discussions of both genera, as they occur in B.C., are presented below.

So how did this all begin, or rather, where did I come in? Adolf Ceska, a Victoria (B.C.) botanist and editor of Botanical Electronic News (BEN) posted a question to the carnivorous plant listserv e-mail discussion group asking if anyone knew whether the *Darlingtonia* found in Pacific Rim National Park, Vancouver Island, B.C. was a natural, disjunct population, or whether it was introduced. I casually replied that I knew it was introduced, as I knew the person who introduced the seed to this bog. The next thing I knew, Adolf was asking me for an article for BEN and Barry Rice was asking me for an article for Carnivorous Plant Newsletter!

The saga began in 1999, when a carnivorous plant enthusiast¹ from Vancouver went on vacation to Oregon and collected a few ripe *Darlingtonia* seed pods. On a subsequent visit to the Pacific Rim National Park's Shorepine Bog², he randomly distributed the seeds as he walked along the boardwalk. The enthusiast told me about the location, but attempts I made at locating the plants in early-summer 2001 were unsuccessful, likely due to the small size of the plants, and a spouse who was more interested in the ocean than a mosquito-infested bog (can you imagine?).

So, it was with a bit of surprise that I read Adolf's question regarding the *Darlingtonia*. In subsequent conversations with other botanists and naturalists, Matt Fairbarns provided me with photos of the plants he had taken in 2004 (see Figures 1 and 2; note the presence of *Drosera rotundifolia* for size reference). The small size of the plants indicated that these were indeed the result of the seed spread in 1999. Matt Fairbarns indicated that the leaves were small compared to natural populations in Oregon, and that the plants had not flowered in 2003. This is not surprising, given that *Darlingtonia* can take more than six years to reach flowering size, and even after that stage plants continue to increase in pitcher size for many years. Although some think that this population may eventually fail, I believe that it is well-established, and if left undisturbed, will persist into the future. Currently, there are four known patches of *Darlingtonia*, but others may easily be hidden among the native vegetation in the bog.

While some people may think that the introduced population of *Darlingtonia* is a natural occurrence in B.C., in fact the only native carnivorous pitcher plant is the common *Sarracenia purpurea* subsp. *purpurea*. This species is widespread across much of Canada and is even the provincial flower of Newfoundland. The Rocky Mountains act as an effective barrier to the

¹Who wishes to remain anonymous.

²At the request of Park officials, I have not revealed the exact location of the plants due to fears that people may leave the boardwalk to search for these plants.



Figure 1: Juvenile *Darlingtonia californica* in British Columbia. Photograph by Matt Fairbarns.



Figure 2: Tiny pitchers of *Darlingtonia californica* in British Columbia. Photograph by Matt Fairbarns.

pitheer plant's spread westward, but a large portion of northeastern B.C. is east of the Rockies. It is here that *Sarracenia purpurea* subsp. *purpurea* has been detected.

A single location for the genus in B.C. was reported by Krajina (1968), and was given as being near Jackfish Creek, south of Fort Nelson. (I repeat this locational data here for two reasons; first, the location was reported in Krajina's paper and second, the location is difficult to access and is now an ecological reserve). Numerous plants were reported as occurring in the location. Lamb (1989) noted a second location existed near the Fort Nelson location. Recent searches of the University of British Columbia (UBC) herbarium records and of the scientific literature have not revealed any new locations. Thus, it appears that these two populations are disjunct from the rest of the range of *Sarracenia purpurea*.

A single plant from the Krajina population was collected sometime in the past (perhaps in the early 1980s) and introduced into cultivation. At one point I was fortunate enough to obtain a division of this plant, but it was not as robust as some of my other *Sarracenia purpurea* subsp. *purpurea*. The one time it produced a flower stalk, the flower was consumed by a greedy slug before opening, though it appeared to be the typical dark red flower.

These plants still pose many unanswered questions. Why does *S. purpurea* subsp. *purpurea* apparently only occur in a very restricted area even though there is suitable habitat in many other locations in northeastern B.C.? Why is *Darlingtonia* naturally restricted to Oregon and northern California, when the climates in the southern coastal region of B.C. and the west coast of Washington are so similar and can support populations of *Darlingtonia*? (There are even the occasional serpentine seeps with *Pinguicula* in B.C., two excellent indicators for *Darlingtonia* in California!) Things to mull over in a mosquito infested bog.

References:

- Krajina, V.J. 1968. Sarraceniaceae, a new family for British Columbia. *Syesis*, 1: 121-124.
Lamb, R. 1989. *Sarracenia purpurea* in Western Canada. *Carniv. Pl. Newslett.* 18. 7-8.

BOARD MEMBER ELECTIONS

The end of this year will mark the end of terms of office for four ICPS board members: Carl Mazur (President), Chris Teichreb, Steve LaWarre, and Richard Myers. The other board members, as well as all the additional volunteers responsible for operating the ICPS, extend their thanks to these officers for the work they have done during their terms of office.

The four officers facing the ends of their terms have not yet indicated if they are interested in running for another term. In any event, all members of the ICPS are encouraged to run for a board position in the ICPS. If you would like to participate in the workings of the ICPS, please email a 250 word election statement to Barry Rice (contact information is on the inside cover of *Carnivorous Plant Newsletter*). Your election statements must be received by 1 August, 2006. In your statement, you may wish to note your experience, why you want to run for office, and what you wish to accomplish. Your statements will be printed in the September issue.

The ICPS is a growing, active organization. In order to participate as a board member, email access is essential. Furthermore, board members are expected to work hard! So while we welcome and encourage your interest as a board member, remember that it is more than a vanity post! Consider running for office—your energy is appreciated and needed!

WHITE-PETALLED *DROSERA MICROPHYLLA* ENDL. FROM NEAR
ESPERANCE, WESTERN AUSTRALIA

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Keywords: ecology — observations: *Drosera microphylla*.

In the coastal granite hills near Esperance (33°49'S, 121°52'E), Western Australia grows a variant of *Drosera microphylla* Endl. that has white petalled flowers and orbicular leaves, and thus differs from the typical form of the species. In this paper this variant is described and compared with published descriptions.

The coast near Esperance is dominated by three different types of environment: coastal sand dunes composed of either quartz sand or carbonate sand of biogenic origin; a subdued low plateau with laterite weathering products; and low, often rounded granite hills that rise above the landscape. Each type of landscape supports a suite of carnivorous plant species, but for now we focus on the granite hills. Whilst the hills are modest by any standard, they occur at or very close to the coast and form enough of a physical barrier to deflect on-shore winds and generate more cloud and rain than other parts of the coast, even if only slightly so. Water runs quickly down the bare granite slopes and is gradually channelled into the headwaters of numerous small intermittent streams. On the edge of bare granite slopes soil formation is minimal. The thin soil is often covered by moss, and a selection of drought-deciduous forbs and annual herbs. It is in this environment that this taxon of *D. microphylla* occurs, and often does so in great abundance (see Back Cover).

The soil dries out quickly in late spring, and the tubers¹ of this sundew are nestled snugly at least 10 cm deep in the soil, where possible, or nestled into any available clefts in the granite surface where the soil is thinner. In autumn the weather cools and the incidence of rainfall increases. Growth commences from the tubers and by mid to late autumn growth emerges at the soil surface. Juvenile plants form a rosette of spatulate leaves but larger plants bypass this stage and immediately begin to form an erect stem with orbicular cauline leaves. A conspicuous characteristic of the taxon is the vibrant red colouration of the leaves and stem, which is made all the more eye-catching by the density at which these plants grow together.

The plants grow throughout the winter and into mid-spring when a surprisingly small number of plants begin to form a terminal inflorescence. I have observed plants of this taxon flowering in October and November in the wild. The sepals are large, smooth and have a metallic lustre, which is typical of this species. The petals are white with an often variable amount of red pigment on the outside base of the petals; at the flower's maturity, this colouration results in a bulls' eye feature that may assist in attracting pollinators (Figure 1).

In late spring to early summer the soil begins to dry out, and the plants senesce and become dormant. The timing of dormancy is variable, and appears to at least partially correlate with soil depth—plants in thin soil senesce before those in deeper or more sheltered soil. This can be seen where plants on the edge of a mossy soil area are dormant whereas those in the deeper soil near the middle are still alive.

¹As the storage and resting organs in subgenus *Ergaleium* are covered by a leaf-derived, readily detachable envelope, they must not be called tubers (in which the adnate skin is not derived from leaves and detachable only by force or after cooking) but are instead what the botanist technically calls corms, cf. the analogous situation in *Crocus* or *Gladiolus*.—ed. (JS)



Figure 1. Detail of an open flower. The red pigment on the outside base of the petal is transmitted through to the inner centre, giving it a dark pink tinge.

Following the format in Marchant and George (1982) this taxon is described as:

Herb with a tuber. Stem erect, 5 to 18 cm tall, glabrous, weakly flexuous, with several bract-like prophylls, 3 to 6 mm long at the base. Leaves alternate, rarely with secondary leaves in the upper axils; lamina orbicular, deeply cupped, 3 mm diameter, peltate, on petiole 8 to 20 mm long. Inflorescence a small panicle, 1 to 5-flowered; pedicels 5 to 30 mm long. Sepals 5, narrowly obovate, apex obtuse, deeply concave 7 to 10 mm long, denticulate, glabrous, iridescent, olive green. Petals 5, obovate, 8 mm long, 7 mm wide, unscented (to the human nose), white with the abaxial surface of the petal base often deep red. Ovary, 1, three-locular, red, ovoid, glabrous, 1.2 mm diameter and 0.8 mm long. Styles 3, 2 mm long, flattened, multiply divided into many terete segments forming a low dome over the ovary. The basal third of the styles are red, with the remainder, including the stigmas, white. Stamens, 5, erect, 4 mm long. Filaments 3 mm long by 0.6 mm wide, pale pink, flattened in cross-section. Anthers, 5, 0.8 mm long, pollen yellow. Bracteoles spatulate, 1 to 2 mm long, olive green to red, glabrous, with entire margins; the apex is often cupped. Seeds oblong, dark grey, flattened, reticulate surface, to 1.8 mm (including membranous apical ends) long by 0.3 mm wide by 0.2 mm thick, the ends extending into often-flexuous wings to 0.6 mm long (Figure 2).

Drosera microphylla is known to be a polymorphic species (Diels, 1906: 121; Lowrie, 1987: 64). This species is endemic to the south west of Western Australia, where it grows in laterite soils in Jarrah forests. Over the majority of its range it consists of olive-green plants with sub-orbicular leaves, and red or orange-coloured petals. A summary of key features for different members of the complex is presented in Table 1 (below):

In this article I have provided a description of a distinctive member of the attractive *D. microphylla* complex. This taxon appears to possess characters that are unique in the complex: an overall red colouration to the plants, deeply cupped cauline leaves and white petals. At this stage the taxonomic status of this entity is not yet known, but the plants appear to form a coherent population, with consistent characters and grows apart from the other members of this complex. Further taxonomic study into this complex appears warranted, and would likely be most rewarding.

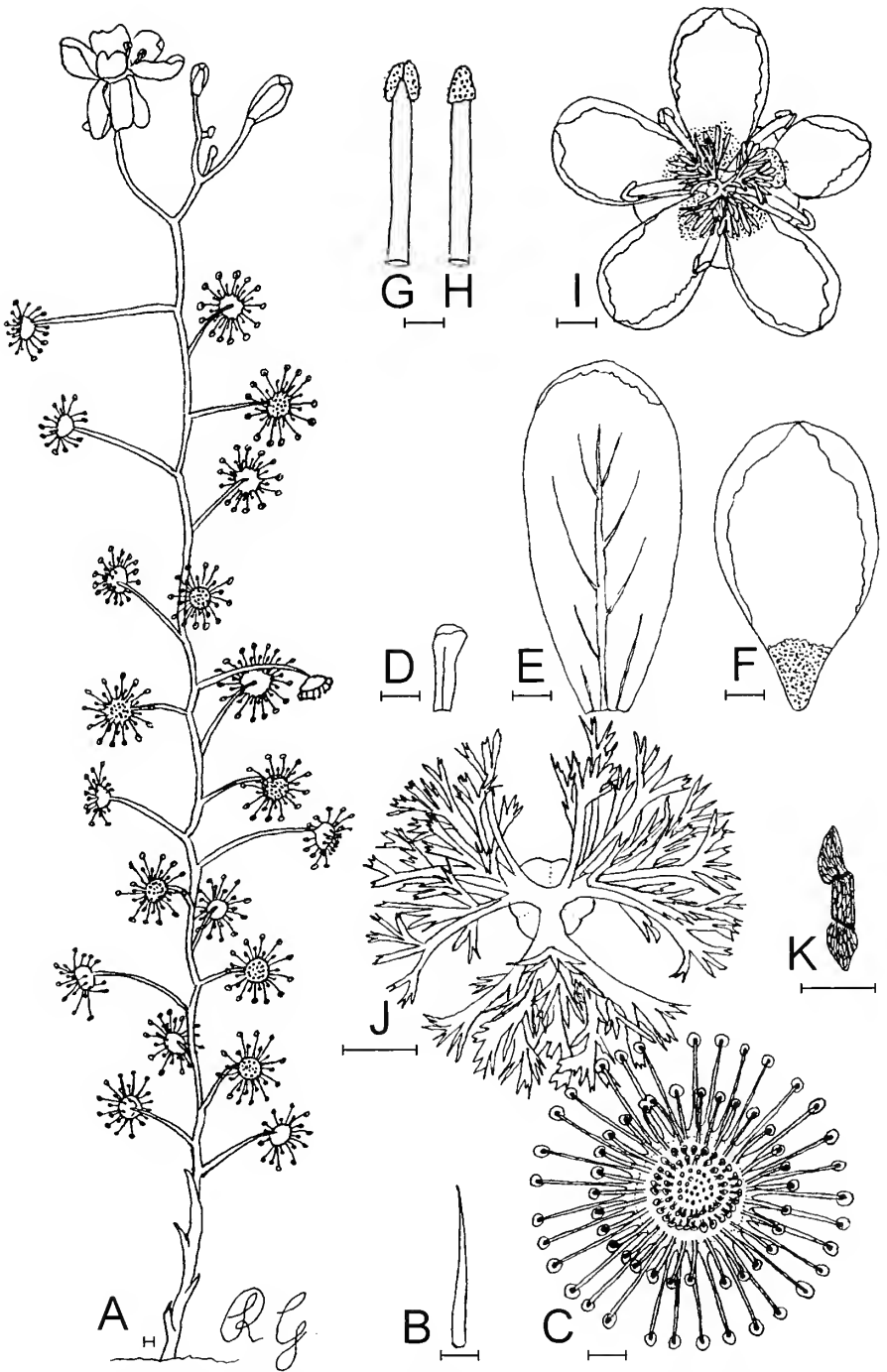


Figure 2. Botanical illustration, by R. Gibson, of the white-petalled taxon of *Drosera microphylla*. A: Whole plant in flower; B: prophyll; C: cauline leaf; D: bracteole; E: sepal; F: petal, with the red base indicated; G: stamen—adaxial view; H: stamen—abaxial view; I: open flower; J: gynoecium; K: mature seed. Scale bar in all cases is 1 mm.

	White-petalled plant	Diels 1906 var. <i>microphylla</i> ¹	Diels 1906 var. <i>macropetala</i> ¹	Lowrie 1987	Orange-petalled plant
Cauline leaf shape & diameter × depth	Orbicular 3 × 1.5-2	Suborbicular 1.5-3 × 1.5-3	Suborbicular 1.5-3 × 1.5-3	Reniform 3-3.5 × 1	Orbicular 2 × 1
Cauline leaf curvature	Deeply cupped	NA ²	NA ²	Shallowly cupped	Shallowly cupped
Petal colour	White to pale pink	Purple	Purple	Red	Orange
Sepal length × width (mm)	7-10 × 3.5-4	8-10 × 2.5	8-9 × 3-3.5	10 × 4	6-7 × 2
Petal length × width (mm)	6-8 × 3-7	6-8 × 3-4	9-10 × 5-9	8 × 5	7 × 3
Plant colour	Red	NA ²	NA ²	Green	Green
Geographic location	Esperance area	NA ²	NA ²	Perth area	Albany area

¹The taxon *D. microphylla* var. *macropetala* and the autonym *D. microphylla* var. *microphylla* were established in Diels (1906).

²This information is not provided in Diels (1906).

Table 1: A summary of variation recorded within the *Drosera microphylla* complex based on descriptions in Diels (1906; p. 119-121) and Lowrie (1987), and a comparison with plants from the Esperance and Albany areas. Plant colour is taken from sun-exposed plants.

Acknowledgements:

I wish to thank Phill Mann for his assistance and company during recent field trips to the Esperance area for further study of this taxon.

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Diels, L. 1906. Droseraceae. In A. Engler (Ed.) Das Pflanzenreich. 26: 1-137.

Lowrie, A. 1987. Carnivorous Plants of Australia: Volume 1. University of Western Australia Press, Perth.

Marchant, M.G. and George, A.S. 1982. *Drosera*. In: (A.S. George, Executive Editor) Flora of Australia: Volume 8, pp. 9-64, 77. Australian Government Publishing Service, Canberra.



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HELIAMPHORA EXAPPENDICULATA, A CLEARLY
DISTINCT SPECIES WITH UNIQUE CHARACTERISTICS

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Keywords: new taxa: *Heliamphora exappendiculata*, Venezuela.

Received: 4 June 2003

Introduction

Due to its remoteness and inaccessibility, the flora of the Guyana Highlands, in the south of Venezuela, remained nearly completely unexplored until as recently as only 50 years ago. Before that time, only a few expeditions had reached the tepuis in the area, e.g. Roraima (Im Thurn 1885), Duida (Gleason 1931) or Auyan (Gleason 1939). The botanical collections from these expeditions were amazing (Im Thurn 1886)—the flora is spectacular even in the extensive savannahs around the tepuis (Schomburgk 1931).

In 1946, another pioneer in the exploration of the tepuis, Felix Cardona, explored Apacara-tepui (a part of Chimanta-tepui). On this trip he observed and collected material of an interesting *Heliamphora* (Cardona 51648).

At approximately the same time, two groups of botanists started to explore this vast area more systematically. One group was led by Julian A. Steyermark, who started his career at the Chicago Natural History Museum. Later on, he became so fascinated in the botany of this extraordinary region that he spent 25 years of his life in Venezuela. In 1984 he returned to the USA to the well-known Missouri Botanic Garden. Never before or afterwards had anyone made so many botanical collections as Steyermark. The other group was from the New York Botanical Garden and was led by Bassett Maguire with the collaboration of John J. Wurdack. One of the largest tepuis, with a surface of 615 km², the huge area of Chimanta-tepui was at that time unexplored. Steyermark and Wurdack made independent expeditions to reach its top in 1953 (Steyermark 1955). Due to its remoteness, Steyermark needed months to reach the top. Wurdack reached the top of Chimanta-tepui on 29 January 1953. He collected material of this region's interesting *Heliamphora* (Wurdack 34262; this material is used as the type for the species described in this paper) on the northwest slopes of Churi-tepui, another part of the huge Chimanta-massif. In the same year, Bernardi organized an expedition to reach the top of Aprada-tepui, an isolated tepui near and to the north of Chimanta. Even though he failed in this goal, he was able to collect material (Bernardi 796) of the same *Heliamphora* species at the base of this tepui. In 1955, Steyermark and Wurdack made another expedition to the Chimanta-massif, and collected yet additional material of this new *Heliamphora*.

After these collections, this taxon was observed only very rarely. In 1978 it was described as a variety of *H. heterodoxa* by Maguire (Maguire 1978). Between 1983 and 1986, Huber organized several helicopter-expeditions to the Chimanta-massif and performed intensive botanical and geological explorations. But in the book where he presented the results of these expeditions (Huber 1992) he never mentioned the distinctive plant. It seems that it was overlooked due to its habitats which are both remote and difficult to access.

Heliamphora exappendiculata (Maguire & Steyermark) Nerz & Wistuba *comb. et stat. nov.*

(Memoirs of the New York Botanical Garden (Vol. 29, 1978): The Botany of the Guyana Highland - Part X: p. 54)—*Var heterodoxi simili sed amphoris sine appendicibus*
Holotype (NY): Venezuela, 29.01.1953, John J. Wurdack 34262.

Rhizomes branching, plants often forming dense colonics. Plants growing in or below



HOLOTYPE OF
Heliamphora heterodoxa Steyermark
 var. *exappendiculata* Maguire
 Bassett Maguire, 1973

KUNHARDT WITHERBEE CHIMANTA MASSIE EXPEDITION, 1952-53
 New York Botanical Garden — American Museum of Natural History
 Estado Bolívar, Venezuela

No. 34262 HOLOTYPE
Heliamphora heterodoxa Steyermark
 var. *exappendiculata* Maguire
 det. Bassett Maguire, 1973

Petals pink, stamens yellow, pitcher appendage slightly developed, frequent on escarpment face in spray of falls, 1 km north of Camp 8 at lower escarpment base, 2050 m elev.

Talus cloud forest, northwest slopes of Churi-tepui (Muru-tepui),
 John J. Wurdack January 29, 1953

Supported by funds provided by Mrs. Silas H. Witherbee, Mr. H. B. Kuehndler, the American Museum of Natural History, and The New York Botanical Garden. Distributed by the Chicago Museum of Natural History and The New York Botanical Garden.

Figure 1: Herbarium specimen 34262 (NY), holotype for *Heliamphora exappendiculata*. Image provided courtesy of the New York Botanical Garden.

vertical cliffs, with the rhizomes growing down, turning upwards and bearing pitchers. Below the cliffs, the rhizomes grow upwards normally. Pitchers ventricose in the lower part, 12-25 cm long, 4-10 cm wide at the upper part. The outer surface of the pitchers loosely covered with simple minute trichomes. The inner surface of the upper part of the pitcher densely covered with fine hairs. The lid completely embedded in the apex of the pitcher, circular to ovate, 5-10 mm long, usually pointed in the apex, approximately forming a small triangle at the inner side roughly. Outer surface of the pitcher covered with short trichomes. Colour of the pitcher pale green, in sunny places it may develop irregular red dots or completely red pitchers. Sometimes the pitchers are green in the lower part and red in the upper part, especially on the inner pitcher surface. Lid usually red, slightly hairy at the outer part. 1-3 flowers. Inflorescence about 40 cm long, peduncle 3-5 cm long, glabrous; bracts 3-4 cm long, bearing rudimentary pitchers. Tepals 4, oblong-lanceolate, 3-5 cm long, 1.5-2 cm wide, white to whitish-pink; 10 stamens in 1 series, filaments 7 mm long, anthers oblong, lanceolate, 8 mm long, 1.2 mm wide. Ovary 3-celled, pubescent, style glabrous. Seed approximately 2 mm long, compressed, ovate, irregularly winged.

Specimens Examined

Churi-tepui (Muri-tepui), 2050 m, 29.01.1953, John J. Wurdack 34262, Holotype (NY); Churi-tepui (Muri-tepui), 2050 m, 29.01.1953 Wurdack No. 34262, ISOTYPE (K); Churi-tepui (Muri-tepui), 2250-3000 m, 26.01.1953 Wurdack No. 34236 (VEN); Churi-tepui, 2100-2200 m, 24.01.1953, Wurdack No. 34172 (VEN); Aprada-tepui, 1000-1100 m, 18.08.1953, Bernardi No. 796 (VEN); Chimanta-massif, Central Section, 1925 m, 5.2.1955, Steyermark & Wurdack No. 441; Torono-tepui, 1875-1950 m alt; 26.02.1955, Steyermark & Wurdack No. 1135 (VEN); Apacapa-tepui, 2125-2300 m, 13.04.1953 Steyermark No. 74888 (VEN, K); Apacara-tepui, 1900 m, 08.07.1946, Cardona No. 51648 (VEN); Amuri-tepui, 1850 m (+/-), 2-5.2.1983, Steyermark *et al.* No. 128489 (VEN).

Geology and Geography

Heliamphora exappendiculata is apparently restricted to Chimanta-tepui and Aprada-tepui (Brewer-Carias 1987), two sandstone-plateaus at the centre of the Gran Sabana. Chimanta is one of the largest tepuis; it is characterized by many dissections, valleys and ravines at the plateau-area. Aprada is smaller than Chimanta and is located close to it in the north-west. It consists of two plateaus, both relatively flat which are divided by a valley. *Heliamphora exappendiculata* seems to be adapted to this high degree of vertical cliffs of Chimanta-tepui, where it grows with few other plants. Due to the diversity of the surface of Chimanta-tepui, many different habitats can be found on the plateau (including vast savannahs, shrubby forests, dry cliffs, wet cliffs and many rivers and waterfalls). It is because of this great diversity of habitats, that three different species of *Heliamphora* exist side by side at the top of Chimanta-tepui, *Heliamphora exappendiculata*, *H. pulchella* and *H. chimantensis*. On Aprada only two species of *Heliamphora* have been recorded so far, *Heliamphora exappendiculata* and *H. pulchella*. Here *Heliamphora exappendiculata* was not found growing on cliff faces but rather in the shade on the bottom of small canyons of the otherwise flat surface of the plateau.

Distribution

Heliamphora exappendiculata is restricted to the Chimanta-massif and Aprada-tepui. So far, most collections have been made from the central and northern parts of these features. It also has been recorded from the base and the top of Aprada-tepui. *Heliamphora heterodoxa* is only known from the top of Ptari-tepui and from the adjacent areas in the Sierra de Lema. All specimens collected from Chimanta-tepui as *H. heterodoxa* (like e.g. Steyermark & Wurdack 374 and 375) belong to the recently described new species *H. chimantensis*. From Auyan-tepui, Steyermark (1984) described a distinct form as "*Heliamphora heterodoxa* var. *exappendiculata* forma *glabella* (Steyermark)." The material was collected by Steyermark at the plateau of Auyan-tepui (J.A. Steyermark 93712, VEN). Closer examination of this specimen, however, revealed that in fact it

represents a highly etiolated *H. minor* plant. We also found material in Caracas labelled *H. heterodoxa exappendiculata* f. *glabella*, collected at the plateau of Aparaman-tepui. (Collected by Bruce Holst at 22.03.1987 (Holst 3485) for the Missouri Botanical Garden herbarium and determined by J.A. Steyermark.) It seems there was some confusion about the collected specimens of the Aparaman-group, because members of the same taxon were also determined as *H. heterodoxa* (Huber & Gorzula, 11.147, VEN), *H. heterodoxa* var. *exappendiculata* (Steyermark *et al.* 132045, VEN), or remained unidentified (Holst *et al.* 2923, VEN). Indeed all specimens currently known from the Aparaman-group belong to *H. folliculata*. These ambiguities can be resolved with current understandings of the new species that have been subsequently described, i.e. *H. exappendiculata* and *H. folliculata*. We hope, that in the future, the type-material for *Heliamphora exappendiculata* f. *glabella* (Steyermark 93712) can be found again for further examinations.

Morphology and Distinguishing Characteristics

Heliamphora exappendiculata can easily be distinguished from other *Heliamphora*-species because it is the only species where the lid is embedded in the surface of the pitcher. In contrast, *H. heterodoxa* has one of the most prominent lids in the whole genus. The pitchers of *H. exappendiculata* are infundibuliform, usually 12-15(25) cm long, whereas in *H. heterodoxa* the plant is in all parts tubular and 20-30(40) cm long. The flowers of *H. exappendiculata* are comparably large with elongated tepals, usually 1-2 flowered; in *H. heterodoxa* the flowers are comparably small with the shortest tepals in the genus, usually 2-4(7) flowers on each inflorescence. The ecological differences are also obvious—*H. exappendiculata* grows at or below vertical, wet cliffs, while *H. heterodoxa* grows exposed at the top of Ptari tepui or in open savannahs in the Sierra de Lema.

Relationships to Other Species

Heliamphora exappendiculata has no close similarities to *H. heterodoxa*, *Heliamphora pulchella*, which also grows at the Chimanta-massiv and on Aprada-tepui, shares with *H. exappendiculata* the short pitchers, but the other morphological characters of the pitchers, lid and flowers are clearly different (see Table 1). Furthermore, the habitats of *H. pulchella* (open bogs and swamps) are different from the habitats of *H. exappendiculata*. The other species from Chimanta-tepui that grows near *H. exappendiculata* is *H. chimantensis*. The pitchers of these two species are clearly different—those of *H. chimantensis* are tubular, elongated pitchers with a well developed lid. The flowers are also easily to distinguish; in *H. chimantensis* the tepals are shorter, lanceolate with broad base, in *H. exappendiculata* the tepals are larger, and oblong-lanceolate.

Morphologically, *H. exappendiculata* shows most affinities to the recently described *H. hispida* (Wistuba & Nerz), which grows about 500 kilometers away at the isolated Neblina-plateau. It has in common with *H. hispida* the short pitchers with a clearly infundibulate upper part, and also the flowers are similar with oblong-lanceolate tepals and 8-10 stamina. Furthermore, both species grow in colonies. But there are clearly differentiating characteristics between these species, e.g. the hairiness of the inner part of the pitcher, the absent lid in *H. exappendiculata*, and the different habitats, e.g. *H. hispida* never has been observed on vertical cliffs.

Etymology

The species epithet “*exappendiculata*” means “without appendage,” and notes the unique characteristic of this species.

Discussion

When Bassett Maguire and Julian A. Steyermark worked on the botany of the Guyana-shield of Venezuela, they had to treat a huge amount of field and herbarium work. When they started their expeditions, this extraordinarily rich flora was nearly unexplored, and even today many parts remain to be explored. It took from 1946, when *H. exappendiculata* was collected for the first time,

	<i>H. exappendiculata</i>	<i>H. heterodoxa</i>	<i>H. pulchella</i>	<i>H. hispida</i>
Pitcher				
Dimensions	12-25 cm long 4-10 cm wide	15-40 cm long 5-6 cm wide	8-20 cm long 3-8 cm broad	15-25 cm long 5-8 cm wide
Shape	Ventricose in the lower part, infundibulate to broad infundibulate in the upper part	Infundibulate to ventricose in the lower third, slightly infundibulate in the upper part, expanded near the mouth	Slightly ventricose in the lower part, narrowly expanded to tubular in the upper part	Slightly ventricose in the lower part, broad infundibulate in the upper part
Lid				
Dimensions	0.5-1 cm long 0.4-0.8 cm wide	1-3.5 cm long 1-1.5 cm wide	0.5-1 cm long 0.3-0.5 cm wide	1-1.5 cm long
Shape	Round to ovate, embedded in the apical end of the pitcher-surface, usually pointed in the apex	Strongly helmet-shaped, very constricted to stalked at the base	Flattened to helmet-shaped, only slightly constricted around the base	Cordate, curved
Inflorescence				
Dimensions	Peduncle 40 cm long, pedicels 3-5 cm long	Peduncle 30-70 cm, pedicels 5-6 cm long	Peduncle 20-40 cm long, pedicels 12 cm long	Peduncle 100 cm long, pedicels 12 cm long
Tepals	Oblong-lanceolate, narrowing near the base	Very broadly lanceolate	Lanceolate, broad base	Lanceolate, broad base
Anthers/ Stamens				
Dimensions	8 mm long	5.5-8mm long	4 mm long	3.5 mm long
Number	10	12	15	10

Table 1: Comparison between *H. exappendiculata*, *H. heterodoxa*, *H. pulchella* and *H. hispida*

until 1978 for this outstanding species to be described. It was first described only as a variety of *H. heterodoxa*, perhaps because the authors—who were aware of its lack of a prominent lid—did not appreciate the other divergent characters. Its description merely notes that “*Var heterodoxi similis sed amphoris sine appendicibus*” (“similar to var. *heterodoxa*, but pitchers without appendix”). Further, it was mentioned that “in the var *exappendiculata* the appendage has become completely or essentially lost, and the inner glandular area lowered to the apex of the leaf”. It seems that the authors only concentrated on the most obvious characteristics—the lacking lid—but were not aware of the other distinct characters of this species, which make it very different from *H. heterodoxa*. Steyermark (1951) wrote of *H. heterodoxa* as being a variable species, but the specimen used to justify this characterization (i.e. Steyermark 59766, with somewhat more infundibulate pitchers) might have been collected in more shaded habitats. In actuality, *H. heterodoxa* is only a moderately variable species. The specimens at the top of Ptari-tepui are narrower near the mouth and more

colourful, compared to the usually greenish specimens that occur in the Gran Sabana or in shaded habitats. In these areas they are somewhat more infundibuliform. Steyermark also felt that *H. heterodoxa* was a variable species because of two other collections, i.e. Steyermark & Wurdack 374, and Steyermark & Wurdack 375. However, these specimens belong to the recently described species *H. chimantensis*. When these incorrectly placed specimens are removed from inclusion with *H. heterodoxa*, the species is seen as being not very variable at all.

We can conclude that *H. exappendiculata* is one of the most distinct and interesting *Heliamphora* species, and one that can be identified clearly on the first sight.

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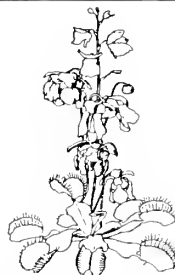
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NAPHTHOQUINONES CONTENT OF SOME SUNDEWS (*DROSERA* L.)

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Keywords: chemistry; *Drosera*.

Introduction

Naphthoquinones are distributed within eight families of flowering plants and are known also in fungi, lichens, and in some spiders. These compounds are characteristic for Droseraceae; they were detected in genera *Dionaea*, *Aldrovanda* and *Drosophyllum* (Culham & Gornall, 1994). Plumbagin (5-hydroxy-2-methyl-1,4-naphthoquinone) and 7-methyljuglone (5-hydroxy-7-methyl-1,4-naphthoquinone) are two main naphthoquinones of the genus *Drosera* (Bonnet *et al.*, 1984). Plumbagin was also detected in the genus *Nepenthes* and in the genera *Triphyophyllum* and *Dioncophyllum* of Dioncophyllaceae. Within angiosperms, 7-methyljuglone is the predominant quinone in Ebenaceae and plumbagin in Plumbaginaceae and Iridaceae (Culham & Gornall, 1994). Aglycones droserone (3,5-dihydroxy-2-methyl-1,4-naphthoquinone) and hydroxydroserone (3,5,8-trihydroxy-2-methyl-1,4-naphthoquinone) are present in minor amounts (Šamaj *et al.*, 1999). Other known minor naphthoquinones are diomuscione and diomuscipulone, identified in *Dionaea muscipula* (Miyoshi *et al.*, 1984). In sundews these compounds probably act as allelopathic, molluscidal, antimicrobial, and antifeedant chemicals (Šamaj *et al.*, 1999).

The taxonomic significance of naphthoquinones within Droseraceae was studied by Culham & Gornall (1994). They found that their occurrences within various species were not useful taxonomic tools because closely related taxa (e.g., subspecies of *Drosera stolonifera*) did not have the same naphthoquinone. Mainly *D. rotundifolia* was studied for naphthoquinones content due to its pharmacological use (e.g., Galambosi *et al.*, 2000; Repčák *et al.*, 2000). The 7-methyljuglone content in *D. rotundifolia* and *D. anglica* in dependence on ontogenetic phases of the leaf were studied by Repčák *et al.* (2000). The highest content was found in young and adult green leaves, while it was lower in older leaves.

In this paper, the content of 7-methyljuglone and plumbagin was studied in several non-European *Drosera* species.

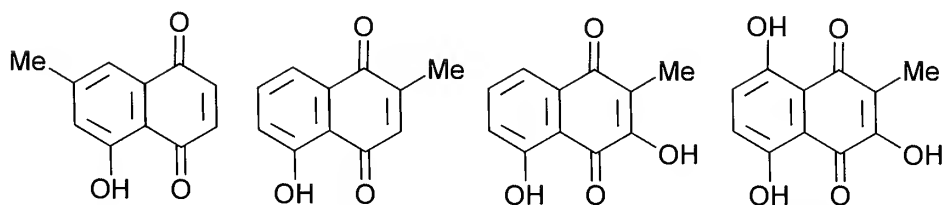


Figure 1: From left to right, 7-methyljuglone, plumbagin, droserone, hydroxydroserone.

Materials and Methods

Plants were cultivated in a greenhouse of the Botanical Garden of P. J. Šafárik University at Košice (Slovak Republic) in pots with peat and were watered with distilled water. For 7-methyljuglone and plumbagin estimation, we harvested fully developed leaves of comparable age from six different plants of each species. Fresh material was homogenized and extracted with

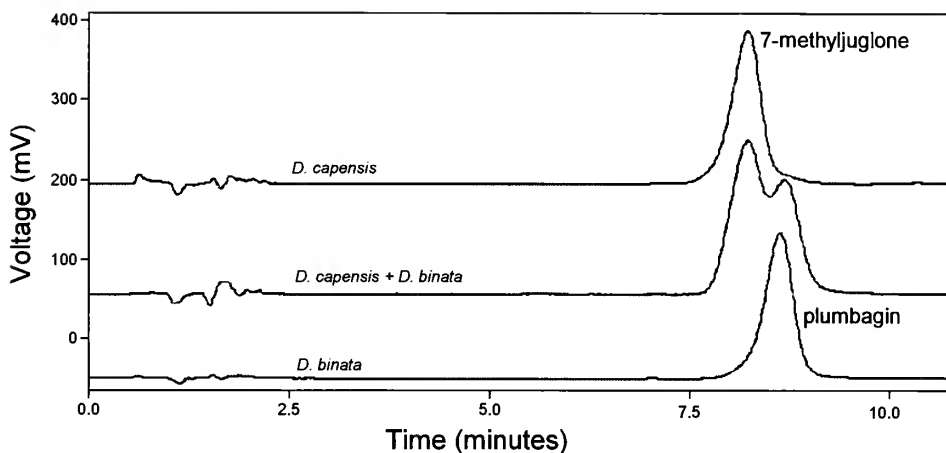


Figure 2: HPLC chromatograms of 7-methyljuglone and plumbagin in extracts from fresh leaves of *Drosera capensis*, *D. binata*, and their mixture.

benzene, evaporated to dryness, dissolved in methanol, and analysed by an isocratic HPLC system. Compounds identity were detected according to their T_R (retention time). UV-VIS spectrum was measured during the analysis to confirm the identity of naphthoquinones. Juglone (Fluka) was used as an internal standard. HPLC conditions: column Biospher SI C 18, 7 μm (Tessek, Prague, Czech Rep.) – 3.3 \times 150 mm, flow rate 0.5 ml min^{-1} . The mobile phase was 50 % acetonitrile (Merck). The detection was performed at 421 nm.

Results and Discussion

We detected 7-methyljuglone in nine out of eleven analysed species and plumbagin in *D. binata* and *D. prolifera*. Very different minimal and maximal values in each species shown in Table 1 could reflect different leaf age and support the well-known fact that naphthoquinone content is negatively correlated with the age of tissue (Repčák & Galambosi, 1994). It is difficult to collect the leaves from the same position on the stem, e.g., in sundews forming leaf rosettes. In spite of this fact, on the basis of naphthoquinone content, we can divide the analysed species into three groups.

The first group, with the highest content of these compounds, is represented by *D. collinsiae*, *D. capensis*, and *D. binata*. More extensive quantitative data were published by Caniato *et al.* (1989). In aboveground parts in *D. binata*, they found a mean plumbagin content 0.23-0.31 % (per unit fresh weight). For this species, we found 0.31 % of plumbagin in fresh leaves. In aboveground parts in *D. capensis*, they found 0.10-0.11 % (FW) of 7-methyljuglone. For this species, we found a value of 0.36 % in fresh leaves. Note that in the sepals and the pistil of *D. capensis*, we detected 7-methyljuglone and, in the same parts of *D. binata* flower, we detected plumbagin.

The second group (*D. communis*, *D. venusta*, *D. admirabilis*, and *D. spathulata*) had a medium content of the analysed compounds but 3-5 times smaller when compared to the first group. No quantitative data referring the content of 7-methyljuglone in some species of this group have been found in the literature.

The third group with low content of the analysed compounds includes *D. burkeana*, *D. adaelae*, and *D. hamiltonii*. They contain approximately 10-times less 7-methyljuglone in comparison with the first group. The position of *D. prolifera* is somewhere in between the first and second group. The variance of values is narrow what can be satisfactorily explained by the shape of leaf rosette when it is easy to determine the leaves of the same age on different plants.

As reported in the literature (Culham & Gornall, 1994), naphthoquinones are present in all four genera of the *Droseraceae*. The plumbagin content in *Aldrovanda vesiculosa* collected from

7-methyljuglone	X±SD	min.	max.
<i>Drosera collinsiae</i>	46.0±12.6 a	24.7	61.6
<i>Drosera capensis</i>	40.8±7.39 ab	33.0	50.5
<i>Drosera communis</i>	9.14±5.05 cd	2.63	14.9
<i>Drosera venusta</i>	8.54±3.25 cd	7.16	11.6
<i>Drosera admirabilis</i>	8.19±2.99 cd	4.63	13.0
<i>Drosera spatulata</i>	7.88±5.42 cd	3.18	16.1
<i>Drosera burkeana</i>	4.93±3.32 d	1.26	8.86
<i>Drosera adelaе</i>	4.03±2.14 d	1.80	6.69
<i>Drosera hamiltonii</i>	3.83±2.34 d	1.26	7.34
Plumbagin			
<i>Drosera binata</i>	30.3± 8.70 b	22.3	46.2
<i>Drosera prolifera</i>	18.7±1.66 c	16.9	21.5

Table 1: Naphthoquinones content in *Drosera* species (mg g⁻¹ of dry weight). Values in the vertical column followed by the same letter do not differ significantly at P<0.05 by Tukey's pairwise comparison; n=6; X, mean value; SD, standard deviation; min./max., minimal/maximal detected value.

different sites or originating from different continents is similar to the content of naphthoquinones in the first group with the highest content of these compounds (for comparison see another paper in this issue of Carnivorous Plant Newsletter; Adamec, *et al.* 2006).

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PLUMBAGIN CONTENT IN *ALDROVANDA VESICULOSA* SHOOTS

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Keywords: chemistry: *Aldrovanda vesiculosa*.

Introduction

Plumbagin is a yellow naphthoquinone (for its chemical structure see Kovacik & Repcak in another paper of this issue) typically occurring in all genera (*Drosera*, *Dionaea*, *Aldrovanda*) of Droseraceae and widespread within the order Nepentales (Bonnet *et al.*, 1984; Juniper *et al.*, 1989; Culham & Gornall, 1994, Tokunaga *et al.*, 2004; Schlauer, 2005). Although the presence of plumbagin or its topoisomer, 7-methyljuglone, in Droseraceae organs can very simply be proved by spontaneous sublimation of these substances and staining plastic materials and organic solvents yellow, both the correctness of analytical procedures for quantitative determination of plumbagin and mainly its physiological functions in (carnivorous) plants are still a matter of discussion. Moreover, plumbagin and its derivatives have long been under the interest of pharmacologists for their antimicrobial effects. Tokunaga *et al.* (2004) have recently demonstrated strong cytotoxicity of plumbagin against cancer cells and also its antifeedant effect against insect larvae.

In *Drosera* and *Dionaea* leaves, plumbagin content usually ranges between 2-3% of dry weight (DW; Tokunaga *et al.*, 2004; Kovacik & Repcak, 2006). In the rootless aquatic carnivorous plant *Aldrovanda vesiculosa* L., plumbagin content has never been determined quantitatively. As sun-adapted *Aldrovanda* plants of green temperate European and Asian populations are typically yellow-green and completely lack anthocyanins, a possibly high plumbagin content in this species could be associated with a photoprotective role. The aim of this paper was to investigate plumbagin contents among all available *Aldrovanda* populations, compare two methods of quantitative plumbagin determination in *Aldrovanda*, and to determine plumbagin content in *Aldrovanda* plants of different populations or having been grown at different irradiances. Thus, the possible photoprotective role of plumbagin was tested.

Materials and Methods

Plant material of *Aldrovanda* for plumbagin content determination was collected from both field sites and outdoor or indoor cultures on 20 August 2004. Adult plants originating from E Poland were collected from artificial sites Ptaci blato 1st pool, and Karstejn fen lake in the Trebon region, S Bohemia, Czech Republic (plants were introduced to these sites, see Adamec & Lev, 1999; Adamec, 2005). Plants at Ptaci blato grew in slight shade, while those at Karstejn were collected from three microsites differing greatly among each other in the level of shading by emergent reed vegetation: sun-adapted plants without any shading, shade-adapted plants, and plants growing in very deep shade. The latter plants grew in dense reed stand, evidently at the light minimum threshold for their growth. They were dark green, very short (only 4-5 cm), and weak. Polish plants were also collected from two outdoor plastic cultivation containers in which they had grown in slight shade (Adamec, 1997). Red plants of three Australian tropical populations from outdoor cultivations (N Australia near Darwin, NT; NW Australia from Kimberley,

NT) or an indoor cultivation (N Australia near Katherine, NT) were also collected. They were grown in slight shade (Adamec, 1999). Ripe turions of Polish plants were collected from Ptaci blato and two outdoor containers on 23 October 2004.

For a qualitative test of plumbagin presence, plant material of fourteen *Aldrovanda* populations was collected from small aquaria in an outdoor collection of plants maintained by one of the authors (LA). The original provenances of these plants were: S and N Russia, N Ukraine, Lithuania, E and W Poland, SW Hungary, S Germany (now Switzerland), Japan (near Tokyo), N Australia (Katherine and Darwin), NW, SE, and SW Australia (for most of them see Maldonado San Martín *et al.*, 2003).

Collected plants were thoroughly washed and shoots were divided into two segments, apex with six adult leaf whorls (denoted as "apex") and subsequent six leaf whorls (7th-12th whorls; denoted as "base"). One apical or basal shoot segment (fresh weight 28-145 mg, DW 2.3-12 mg) or one turion (DW ca. 4 mg) was used for one determination. Segments or turions were blotted dry and extracted three times with 1 ml diethyl-ether for about 20 min. before DW of the biomass was estimated. Pooled extracts were alkalized by adding 1 ml 0.1 M NaOH and thoroughly shaken for a few sec. As a result of alkalization, the extract turn orange-red (i.e., bathochromic effect) and plumbagin was dissolved in the aqueous phase. The aqueous phase was diluted ten times with distilled water and optical density measured against blank sample at 400 nm. Plumbagin standard (practical grade P7262, Sigma) was used to obtain calibration curve in the same way. Results are expressed in % DW. Although this method of plumbagin extraction and determination is very simple and fast some objections may arise as to the specificity of this determination. Four parallel plants of each variant were dried shortly at 40°C, wrapped to an aluminum foil, and sent by post to the Laboratory of L. Gastinel (Univ. Limoges, France) for HPLC method of plumbagin determination. After they were overwintered in a refrigerator at 3°C, living turions from Ptaci blato were also sent by post to the Laboratory of L. Gastinel on 17 March.

Here, 3 to 20 mg DW of *Aldrovanda* shoots were extracted in glass tubes with 2 ml of diethyl-ether three times for 30 min. The pooled extracts were allowed to dry overnight by evaporation. The extracts were then resolubilised with 1 ml of pure methanol in the presence of 0.1% formic acid (FA). Twenty-five µl of the samples were injected on an HPLC column (Nucleosil 250 × 4.6 mm 300 Å C18 5µ with a guard column at a 0.5 ml min⁻¹ flow rate. Elution of substances absorbing at 400 nm (naphthoquinone ring) was followed by using a 45-min linear gradient from 50% methanol: 50% water with 0.1% FA to 80% methanol: water with 0.1% FA. Quantitative calibration of plumbagin was performed using the plumbagin standard (see above) dissolved in pure methanol with 0.1% FA and injected in the HPLC at different volumes.

MS spectra of the 400 nm absorbing material purified from HPLC gradient (retention time around 21 minutes) were recorded after the injection in the Turbolon ESI spray coupled with Q-trap mass analyser (Applied Biosystems) with parameters, ion spray voltage 5000 V, declustering potential 30 V, flow rate 40 µl min⁻¹. m/z peaks were recorded in the range 50 to 500 amu with the EMS protocol from Analyst 1.4 (Applied Biosystems).

Plumbagin presence was tested using a thin-layer chromatography. One shoot apex of each population, 6-8 mm long, was blotted dry and extracted with 0.25 ml diethyl-ether for 15 min. The extract (20 µl) was dropped on a TLC silica plate F60 and developed first in methanol (to focus the front) and then in toluene for about 15 min. Leaf extract of a non-flowering plant of *Drosera intermedia* was co-chromatographed as standard for plumbagin detection.

Results and Discussion

The presence of plumbagin was clearly determined in all fourteen world populations of *Aldrovanda* but 7-methyljuglone was not detected. Comparing the two methods of plumbagin content determination, direct colorimetric determination (see Table 1) and that using HPLC (see Table 2), there is a much better agreement of the results for apical than for basal segments. Direct colorimetric determination in the same material led to shoot contents greater by 0-90% in apices,

while 2-5 times greater in bases, than using HPLC. There are some possible reasons for this difference. First, the diethyl-ether extract at the direct colorimetric determination might contain also some other ether-extractable substances absorbing at 400 nm, although no such contaminant has been identified so far. Second, due to sublimation of plumbagin, a good deal of this volatile substance could be lost during drying or posting the plant material or solubilized in the plastic phase of the aluminum foil. It is conceivable this loss affected particularly the basal stem segments and Australian plants with more opened leaves or lower biomass, in which the differences between the two methods were more pronounced than in the apices or turions.

Overall, plumbagin content in apical segments ranged between 1.2-4.8% DW and that in basal ones between 0.4-5.0% DW (see Tables 1, 2). The mean plumbagin content of about 2-3% DW in *Aldrovanda* apical shoot segments corresponds to that found in two *Drosera* species (1.9-3.0% DW; Kovacic & Repcak, 2006) or in *Dionaea muscipula* (about 3 % DW; Tokunaga *et al.* 2004). Thus, plumbagin content in *Aldrovanda* shoot is not greater than in other genera of Droseraceae. However, with either assay method, plumbagin content was evidently greater in apical than basal shoot segments in Polish plants but this difference was not too distinct in dark-red Australian plants (see Tables 1, 2). This gradient in plumbagin content in *Aldrovanda* shoot segments of different age is in a good agreement with Repcak *et al.* (2000) who found a decrease of 7-methyljuglone content in older leaves of *Drosera* spp. Obviously, plumbagin is released from old and ageing tissues of *Aldrovanda* to ambient medium (Adamec, unpubl.). In *Aldrovanda*, plumbagin content in shoot apices was similar to that in turions (Tables 1, 2). The data on plumbagin content do not support the hypothesis that this substance has a specific and light-regulated photoprotective role in *Aldrovanda* as the content was the same in both sun- and shade-adapted plants. Nevertheless, due to optical properties of plumbagin (absorption of blue light and UV), it is possible to assume certain role in photoprotection. These results support the view that the main and primary role of plumbagin in Droseraceae is antifeedant and antimicrobial, thus protecting the plants against herbivores and microbial parasites (Tokunaga *et al.* 2004).

Origin and light exposure of plant material	Plant A		Plant B	
	Apex	Base	Apex	Base
Shoot segments				
E Poland: Ptaci blato 1st pool, slight shade	3.34	1.66	3.13	1.67
E Poland: Karstejn fen lake, sun-adapted	2.75	2.00	2.54	1.68
E Poland: Karstejn fen lake, shade-adapted	2.18	1.70	2.37	1.47
E Poland: Karstejn fen lake, very deep shade	2.31	1.46	3.04	2.49
E Poland: culture I; small container, slight shade	3.78	2.78	3.64	2.54
N Australia, Katherine: indoor aquarium, slight shade	4.55	3.41	5.95	3.93
Turions	Turion A		Turion B	
E Poland: Ptaci blato 1st pool, slight shade	2.68		3.21	
E Poland: culture I; small container, shade	2.69		2.39	
E Poland: culture II; big container, shade	3.50		3.68	

Table 1: Content of plumbagin (in % of DW) in apical and basal shoot segments of different strains and in ripe turions of *Aldrovanda vesiculosa*. Apical shoot segments contained shoot apex + the first six adult leaf whorls, while the basal ones the subsequent six leaf whorls (i.e., the 7th-12th ones). Results for two different plants or turions A and B are based on measurement of optical density at 400 nm of alkalized diethyl-ether extract.

Origin and light exposure of plant material	Plumb. content (% DW)	
	Apex	Base
Ptaci blato	2.2±0.9 ^a	0.4±0.07 ^b
Karstejn: sun-adapted	2.1±0.9 ^a	0.5±0.05 ^b
Karstejn: shade-adapted	2.4±0.4 ^a	0.7±0.1 ^b
Karstejn: deep shade-adapted	1.2±0.4	—
Culture I: small container	2.0±0.7 ^a	0.5±0.1 ^b
NW Australian: outdoors	1.2±0.2 ^a	0.5±0.06 ^b
Turions-Ptaci blato: 1st pool	2.4±0.5	

Table 2: Plumbagin content determined in diethyl-ether-extracted dry *Aldrovanda* biomass using HPLC. For apical and basal segments, see Table 1. Except for Australian plants, the others were from E Poland. Means±SD of 3-4 independent analyses are shown. The different letters within the same row denote statistically significant difference at P<0.05 (t-test).

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LOOKING BACK: CPN 25 YEARS AGO

Previous CPN coeditor and ICPS cofounder Don Schnell published a now-classic review of all the infraspecific *Sarracenia purpurea* taxa then known, including a variation that resulted because of its growing in marl fens. After twenty-five years, this treatment would be modified by the addition of *Sarracenia purpurea* subsp. *venosa* var. *montana*, *Sarracenia purpurea* subsp. *venosa* var. *burkei* f. *luteola*, perhaps a nod to the veinless expression of *Sarracenia purpurea* subsp. *purpurea*. Of course a modern author would also have to address the issue of whether to accept the *Sarracenia rosea* species as having merit.

BOOK REVIEW

Correa A., M.D., and dos Santos Silva, T.R. 2005. *Drosera* (Droseraceae): Flora Neotropica Monograph 96. 0-89327-463-1, 72 p., black and white figures and maps. Paperback, US\$25.00+shipping. Order from www.nybg.org or 718-817-8721.

Reviewed by Fernando Rivadavia

This 72-page publication (in Spanish) on Droseraceae is a new addition to the Flora Neotropica series, published by the New York Botanical Garden. The authors M.D. Correa A. & T.R.S. Silva have published a few works on Droseraceae in Latin America over the past 30 years, including the recent *D. peruensis* T.Silva & M.D. Correa.

After a brief introduction and taxonomic history of the genus *Drosera* in the New World tropics, the authors describe general morphology of native species, and present interesting scanning electron microscope images of seeds and glands on leaves. The sections that follow cover cytology, palynology (with more SEM images), phytochemistry, infrageneric classification, geographic distribution (with numerous maps covering every species), floral biology and seed dispersal, ecology, conservation, human uses, and finally the taxonomic treatment which takes up nearly forty pages with detailed descriptions of each species, including morphology & distribution.

The first impression is that this is a very impressive work, probably one of the largest and most complete taxonomic publications on *Drosera* since Diels' monograph in 1906 or Allen Lowrie's three volume treatment of the Carnivorous Plants of Australia. The authors should at least be praised for the effort of bringing together so much information spread throughout dozens of publications spanning mostly the last century.

Unfortunately, only a slightly less superficial reading of this publication will bring to light a disheartening endless series of oversights and errors. These range from numerous misspellings, maps with dots in wrong places, and contradictory statements (sometimes even in succeeding paragraphs) to more serious mistakes such as quotes from important publications (including Juniper, Robins & Joel's "The Carnivorous Plants" and Takahashi & Sohma's "Pollen Morphology of the Droseraceae and its Related Taxa") which were wrongly interpreted by the authors, possibly due to a poor grasp of English.

Knowledgeable botanists may identify further signs of worry, such as the less-than-precise botanical drawings, the often vague morphological terminology, the non-inclusion of important herbarium collections from the past decade (especially those at the University of São Paulo, Brazil), the non-citation of more recent molecular phylogenetic data, and the obvious failure to even attempt addressing the taxonomic difficulties posed by the more complicated species complexes. The odd assortment of taxa dumped under *D. montana* A. Saint-Hilaire, with no recognition even of varieties, is absolutely indefensible.

The reader will hopefully remember that this work is not the final say in the matter of the Droseraceae of the New World tropics. Unfortunately the recently published *D. camporipestris* F.Rivadavia, *D. grantsau* F.Rivadavia, *D. tentaculata* F.Rivadavia, and *D. viridis* F.Rivadavia were not mentioned in this publication. New species will certainly continue to be described from this biologically wealthy area and new taxonomic revisions will be made.

The overall sum of problems detected in this publication is simply inexcusable for two main reasons. First of all, most of the errors could and should have been pointed out by careful reviewers. Second, the authors seemingly did not realize the importance of this publication, that any and all errors published, as well as inadequate taxonomical treatments, will be propagated and multiplied—since this will be a reference to numerous other authors for at least decades to come.

Unfortunately, Flora Neotropica Volume 96 illustrates a failure in the process of authoring, editing, and reviewing a scientific work, and its legacy will be with us for a long time. I have not reviewed the other volumes in the series and so cannot say if this problem is limited to the treatment of the Droseraceae.

LITERATURE REVIEWS

Akhriadi, P., Hernawati, and Tamin, R. A. 2004. A new species of *Nepenthes* (Nepenthaceae) from Sumatra. *Nuystia* 15: 355-393.

The authors identify *Nepenthes rigidifolia* as a new highland species from north Sumatra. This is apparently the same entity as discovered by C. Lee, and described as “*Nepenthes* species A” in Clarke (2001, *Nepenthes* of Sumatra and peninsular Malaysia); it has also been given other trade names by nurseries. *Nepenthes rigidifolia* has affinities to *N. bongso*, *N. ovata*, and *N. spectabilis*, and the various differences are described in the paper—there are no single “spot characteristics” that easily identify this species.

It is always a pleasure to see floristic works being performed by regional botanists. However, I encourage authors, especially those writing in a second language, to seek assistance in drafting their papers—the grammar in this work is sometimes confusing and detracts from the clarity of the overall findings. (BR)

Alm, T. 2005. *Pinguicula vulgaris* (Lentibulariaceae) and its uses in Norway. *Sida*. 21: 2249-2274.

This comprehensive review of how this plant was (and still is!) utilized in Norway is a treasure-trove for those seeking evidence of strangeness in humanity. For examples, *Pinguicula vulgaris* has been given many common names, my favorites being “gnome-bite grass,” “slime-grass”, “old woman’s mouth,” and quite inexplicably “thickening old man.” Its connection to making tettemelk is discussed, and a photograph is presented of such a viscous milk (Tjukkmjøl) commercially available in Norway. Furthermore, we learn that *P. vulgaris* is useful to treat soreness in reindeer teats, and can be used to calm down cows that have mated. Furthermore, it has some minor magical properties: if laid under a girl’s pillow, she would dream of their coming husband. And that’s not all... (BR)

Berry, P.E., Holst, B.K., Yatskievych, K. (eds.), 1998-2005. Flora of the Venezuelan Guayana. Vols 4: 697-703, 5: 782-803, 9: 138-144.

With the publication of Volume 9, the treatment of the last of the carnivorous monocots of the tepuis is complete. In total, fourteen *Drosera*, seven *Genlisea*, forty-six *Utricularia*, and ten *Heliamphora* are discussed with keys, line drawings, and short descriptions. This is an excellent resource for those interested in the species from this region. Of course, new species have been described that are not described in these treatments; such new species are noted in the literature reviews of Carnivorous Plant Newsletter. (BR)

Carow, T. 2005. *Fleischfressende Pflanzen*. Kosmos Garten. ISBN 3-440-10176-2 (in German)

Master carnivorous plant photographer Thomas Carow has written a small (48 page), illustrated book on carnivorous plants. An introductory work, it discusses horticulture of carnivorous plants in the home and garden, minibogs, and terraria. Short treatments are given of the carnivorous genera. Carow’s photographs, of course, are delightful! Interested customers should contact German colleagues to coordinate a purchase. If nothing else, copies can be bought directly from the author (carow@t-online.de) for approximately US\$10, including shipping. (BR)

Degtjareva, G., Casper, J., Hellwig, F. & Sokoloff, D. 2004. Seed morphology in the genus *Pinguicula* (Lentibulariaceae) and its relation to taxonomy and phylogeny. *Botan. Jahrb. Syst.* 125: 431-452.

The title is slightly misleading, as the species studied are predominantly Eurasian, and only one (*P. moranensis*) from Mexico. Although the authors are convinced micromorphological features of the seed surface are significant at sectional, specific or infraspecific level, the most striking characteristic of the studied seeds is their similarity. Particularly in comparison with the huge structural diversity

found in the seeds of the closely related genus *Utricularia*, the seeds of *Pinguicula* are best described as essentially uniform. The members of *P.* sect. *Pinguicula* (to which most of the studied species belong) share the presence of furrows between the outer parts of the anticlinal walls of adjacent exotesta cells and an always monocotyledonous embryo. (JS)

Garrido, B., Hampe, A., Marañón, T., and Arroyo, J. 2003. Regional differences in land use affect population performance of the threatened insectivorous plant *Drosophyllum lusitanicum* (Droseraceae). *Diversity and Distributions*. 9: 335-350.

The authors surveyed *Drosophyllum* sites and assigned four age classes to the plants observed. This allowed them to infer how well new plants were being recruited, and to understand more about the status of the populations in the wild. The five sites studied in Morocco were damaged from heavy grazing, although the plant's range in this country was probably never extensive. The twenty Spanish sites included the places most likely to retain *Drosophyllum* in the future, since they included populations in the Los Alcornocales Natural Park. The seven Portuguese sites are highly impacted by development of housing and infrastructure, and also plantations. Seedling recruitment at such sites is poor, and *Drosophyllum* is likely to go extinct at these sites. (BR)

Lowrie, A. 2005. A taxonomic revision of *Drosera* section *Stolonifera* (Droseraceae) from south-west Western Australia. *Nuytsia* 15: 355-393.

All taxa of section *Stolonifera* ("fan-leaved" sundews, of which some have peltate and not fan-shaped leaf blades) were already featured in *Carnivorous Plants of Australia*, Vol. 1, by the same author (Univ. of W. Australia Press, 1987, ISBN 0 85564 254 8), from which the drawings have been reproduced. This time the species descriptions are more detailed than in the book: synonyms, basionyms and types are cited, and lists of examined specimens are added (but maps and colour photographs are missing). SEM photomicrographs of the seeds and a schematic body plan of all species complete the account. The most notable change is all former subspecies of *D. stolonifera* are elevated to species rank, i.e. *D. stolonifera* subsp. *humilis*, *D. stolonifera* subsp. *monticola*, *D. stolonifera* subsp. *porrecta*, *D. stolonifera* subsp. *prostrata*, and *D. stolonifera* subsp. *rupicola* are treated as the new species *D. humilis*, *D. monticola*, *D. porrecta*, *D. prostrata*, and *D. rupicola*. *Drosera stolonifera* subsp. *stolonifera* is retained as a more narrowly defined species, *Drosera stolonifera*. *Drosera purpurascens* (that has formerly been attributed to *D. stolonifera* subsp. *stolonifera*) is now found identical with what has been described as *D. stolonifera* subsp. *compacta*, so *D. purpurascens* is the correct name of the latter taxon if regarded a species different from *D. stolonifera*. (JS)

Širová, D., Adamec, L., and Vrba, J. 2003. Enzymatic activities in traps of four aquatic species of the carnivorous genus *Utricularia*. *New Phytologist*. 159: 669-675.

By examining the enzymatic activity in four species of aquatic *Utricularia* (*U. vulgaris*, *U. australis*, *U. foliosa*, *U. aurea*), the authors were able to detect the presence of acid phosphatase inside the bladders. It is unclear if the creation of this enzyme is due to the plant itself, or organisms living inside the bladders and resisting consumption. (BR)

Wistuba, A., Carow, T., Harbarth, P., and Nerz, J. 2005, *Heliamphora pulchella*, eine neue mit *Heliamphora minor* (Sarraceniaceae) verwandte Art aus der Chimanta Region in Venezuela. *Das Taubblatt*. 53/3: 42-50.

The new species *Heliamphora pulchella* is described. Previously regarded as a form of *Heliamphora minor*, this new species is distinguished by the long (5 mm, 0.2 inches) hairs on the inside of the pitcher. (BR)

UNEXPECTED HYBRIDS OF SPECTACULAR BLADDERWORTS SPECIES

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Keywords: cultivation; hybridization, *Utricularia*.

Introduction

The genus *Utricularia* is divided into 35 sections. Two of these sections—*Iperua* P. Taylor and *Orchidioides* DC.—have some of what are arguably the most spectacularly large and beautiful species in the genus. For examples, the beautiful white-flowered *U. alpina* and the red-flowered *U. quelchii* are both from section *Orchidioides*; the huge peltately-leaved *U. nelumbifolia* and hugely-flowered *U. humboldtii* are from section *Iperua*. Since these various species do not usually grow together in nature, and presumably have different pollinators, hybridization is not known from the wild.

It is nearly as difficult for attempts at hybridization to be made in cultivation. It is unfortunately rare for bladderworts from these sections to flower in cultivation. Synchronous flowering of different species from these sections to flower at the same facility is altogether sporadic. However, over the past fifteen years we have had a few opportunities to attempt hybridizations of these plants at the Botanic Gardens of Liberec.

To date, the hybrids are all infertile, but they expand vegetatively. The first successful hybrid cross was made between *U. humboldtii* (female) and *U. quelchii* (male) in 1990. The resulting plant is very similar to *U. humboldtii*, but it is distinctly smaller, leaves being mostly about 16 cm high. Following the nature of the seed parent, it does not produce bulbs but does produce aerial offshoots. The first flower of the hybrid, produced in August 1997, had 43 mm broad lower lip (see Figure 1). This hybrid makes an effort to produce flowers only sporadically, and that is why it is a poor horticultural plant (and not worth, in my opinion, being registered as a cultivar). Nevertheless, the successful hybridization of the species belonging to different sections of their genus is very interesting (see Discussion section, below).

The hybridization between *Utricularia quelchii* (female) and *U. praetermissa* is quite different, in being an easier plant to grow and flower. Accordingly, I have established a cultivar name for it (*Utricularia* ‘Jitka’; Studnicka (2005)). I have also tried to make the same cross, but inverting it so that *U. praetermissa* was used as the female plant. The results were plants that produced flowers that look very much like the archetypical *U. praetermissa*! I suspected autogamy to be occurring (which would be very unusual in the section *Orchidioides*) and confirmed this later, by means of an isolated specimen of this species which produced viable seed.

Yet another hybrid was produced in 2000 between *U. alpina* (female) and *U. campbelliana* (male). This hybrid is characterized by flowers 54-59 mm across, and which are pallidly cerise (see Figure 2). The lower lip of the corolla is saddle-shaped, because it droops down on both sides. There is a golden-yellow palate splotch on the lower lip. The upper lip is longer than the upper calyx lobe. Flowers hang pendently on very thin, 20 cm tall peduncles. There is a whorl of three bracts on the stem, quite like in *U. campbelliana*. The plant is tuberous, and much smaller than *U. alpina*—spathulate leaves are at most only 7 cm long and 1 cm broad. Cultivation of this hybrid is unfortunately difficult, as in *U. campbelliana*. That is why the novelty, which bloomed for the first time in 2002, is probably unsuitable to most growers, and is not deserving of cultivar status.



Figure 1: A cross made between *U. humboldtii* (female) and *U. quechii*.



Figure 2: A cross made between *U. alpina* (female) and *U. campbelliana*.

Of the two very similar species *U. alpina* and *U. praeternissa*, autogamy was only observed in *U. praeternissa*.

It is striking that the cross *U. humboldtii* × *U. quelchii* produced viable seed, since the two parent plants are in different sections in the genus *Utricularia*. From this we could deduce that the sections *Iperua* and *Orchidioides* are closely related. Alternatively, we could deduce that *U. humboldtii* is more properly identified as a species from the section *Orchidioides*. Furthermore, if *U. humboldtii* were transferred to section *Orchidioides*, the section *Iperua* would have to be given a new name since it will have lost its type species. Should we accept this transferral, we find that the section *Orchidioides* (including *U. humboldtii*) and the section that was previously called *Iperua* occur in geographically separated areas. Section *Orchidioides* would occupy the Andes, Venezuelan mountains, and the northern part of the Brazilian Shield. The section that was once called *Iperua* (but without *U. humboldtii* would be given a new name) would be restricted to the southern part of the Brazilian Shield. The primaeval Shield was divided into the northern and southern parts by the much younger Amazonian Basin. This geo-historical separation could be the reason for the segregation of the sections *Orchidioides* and *Iperua*. We find various analogies in both sections, like tuberous species (*U. geminiloba* in *Iperua*!) and species symbiotic to *Bromeliaceae*, with aerial shoots.

The counter-hypothesis, i.e. transferring *U. quelchii* into section *Iperua* is not as compelling since the geographic separation of the two new sections is not as clean. Furthermore, there are a number of other species in section *Orchidioides* (such as *U. endresii*) that are clearly closely related to *U. alpina*.

Perhaps in these ruminations, we should also take into consideration botanical intuition. If you compare the strange solid spatulate dark-green leaves of both *U. humboldtii* and *U. quelchii*, they seem to be native sisters; and the hybridization discussed here seems to be less surprising.

References:

Studnicka, M. 2005, New cultivar: *Utricularia* 'Jitka', Carniv. Pl. Newslett. 34: 27-28.



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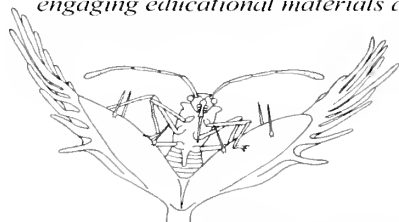
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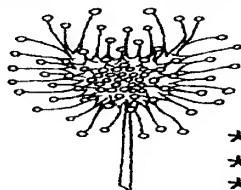
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