

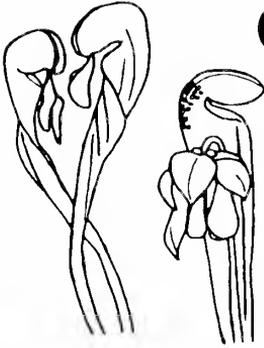
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CARNIVOROUS PLANT NEWSLETTER

VOLUME 21, NUMBER 3

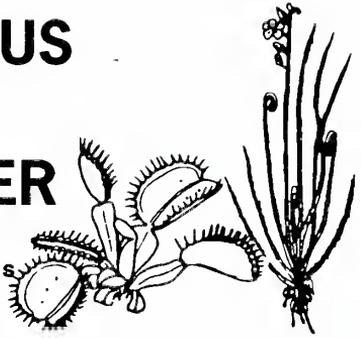
SEPTEMBER 1992





CARNIVOROUS PLANT NEWSLETTER

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Volume 21, Number 3
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Front cover: *Drosera* sp. "white flower." A new species from Parque Nacional das Emas, Brazil. Photo by Fervando Rivadavia. Please see article beginning on page 14.

Rear cover: *Drosera villosa* along the Caminho do mar, Brazil. Photo by Randy Lamb. Please see article beginning on page 20.

The co-editors of CPN would like everyone to pay particular attention to the following policies regarding your dues to the ICPS.

All Correspondence regarding dues, address changes and missing issues should be sent to ICPS c/o Fullerton Arboretum, CSUF, Fullerton, CA 92634. DO NOT SEND TO THE CO-EDITORS. Checks for subscription and reprints should be made payable to ICPS.

All material for publication, comments and general correspondence about your plants, field trips or special noteworthy events relating to CP should be directed to one of the co-editors. We are interested in all news related to carnivorous plants and rely on the membership to supply us with this information so that we can share it with others.

Views expressed in this publication are those of the authors, not necessarily the editorial staff.

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ICPS Seed Bank

(inventory as of 12 August 1992)*

Byblis liniflora

Drosera aliciae, *D. binata* "Coromandel penn" (6), *D. bin.* "hauki plain" New Zealand, *D. bin.* "Northland, New Zealand", *D. burkeana*, *D. burmannii*, *D. capensis* (5), *D. cap.* NL (10), *D. capillaris* "Brasiliensis", *D. capil.* pink (2), *D. dielsiana* (2), *D. filiformis*, *D. glanduligera* (5), *D. intermedia*, *D. int.* "tropical", *D. indica*, *D. rotundifolia*, *D. rot.* "southern BC", *D. rot.* "New Jersey", *D. spatulata* (13), *D. spath.* "hauraki plain" (7), *D. spath.* "kansai" (2), *D. spath.* "Hong Kong" (5), *D. spath.* "pink flower", *D. villosa* "narrow leaf" Camino do mar, Brasil; Pygmy *Drosera* → *D. occidentalis occidentalis* (1), *D. pulchella* (2), *D. pygmae* (10); Tuberosus *Drosera* → *D. auriculata* (3), *D. auriculata* "New Zealand", *D. auric.* Melbourne, *D. peltata* "New Zealand".

Pinguicula vulgaris

Utricularia delicatula Waikato NZ, *U. novae-zealandeae* Hauraki plain, *U. longifolia* (8), *U. caerulea*, *U. hispida* (13), *U. tricolor* (13), *U. livida* (2)

Nepenthes khasiana, *N. lowii*, *N. ventricosa* X (*inermis* X *bongso*)

Sarracenia alata, *S. flava*, *S. flava* Eastern Virginia, *S. leucophylla* (almost white), *S. leucophylla*, *S. purpurea* ssp. ?, *S. purp. purp.* (5), *S. purp.* "BC", *S. purp. purp.* "Quebec", *S. purp. purp.* "Mich" (10), *S. purpurea* X *flava* X self (2), *S. [leuco* X (*rubra* X *leuco*)] X *purp.* X *flava*.

*For reference purposes only. Please send SASE or two IRC's to Gordon Snelling (ICPS Seed Bank; 300 West Carter Drive; Glendora CA 91740-5915; USA) for most recent list. Price is US\$1.00/packet. Cash, check, postal money orders, giro/mandat postal, etc.

News & Views

Thomas Alt (Waldstrasse 12, 6610 Lesach-Aschsach, Germany).

I will have plantlets of *N. rajah* grown in sterile conditions by *in vitro* agar culture for sale. If anyone knows of the following species, I would like to hear from you: *N. clipeata*, *N. spathulata*, *N. tomoriana* and others.

Pat Kite (5318 Stirling Ct., Newark, CA 94560).

For those readers who want to purchase a specially bound copy of the following book, it is available from James W. Beattie, Rare Books, 105 N. Wayne Ave., Wayne, PA 19087: Darwin, Charles. INSECTIVOROUS PLANTS. N.Y. Appleton, 1875 5x8. 462pp. + ads. American edition. \$125.00.

Randy Lamb (P.O. Box 6112, Whitehorse, Yukon, Canada Y1A 5L7).

Greetings from the great white north! Recently, I tackled a personal project that I had wanted to do for the last decade. I created my own index to the last 20 years of CPN issues. During this dust covered activity, I re-discovered many interesting facts and trivia. Who else can remember:

- Who created the artwork for the CPN logo?
- What was the scientific name of *Darlingtonia* in the 1970's?
- What one CPN issue came out in April instead of March?

As I started with CPN 1(1) 1972, I was surprised at how many people, who we all know today, were there in the beginning. Each list of new subscribers was gleaned eagerly for familiar names and a hint at their own CP background. The member biographies were all re-read. I found it amusing to see my own name pop up for the first time in the subscription list of volume 5(4), 1976. Plant popularity trends came and went, then returned after a decade. I know many people will be surprised at how early *Heliamphora* or pygmy and tuberous *Drosera* were cultivated by ICPS members, they weren't something new for the late 80's.

So many years have gone by since 1972 and so many new members have joined our ranks. As you read through the two decades of issues, you see many names show up for the first time and appear along with many informative articles. Sometimes, after a couple of years, the names disappear from the pages of CPN but luckily most of these people stay with the faith. I highly recommend to other CP'ers to take a trip down memory lane and learn more about their society's background.

In closing, I will leave you with some food for thought. In the first 5 years of the CPN, there were over 23 references and articles on *Aldrovanda*, can someone tell me what ever happened to this plant and who grows it today?

Tom Kahl (1351 Lake Washington Blvd. S., Seattle, WA 98144).

I recently wanted to take a trip to Peter D'Amato's greenhouse, "California Carnivores" but in the past few years I have accumulated hundreds of *Nepenthes*. Watering the plants took more time than I had and the *Nepenthes* in hanging pots were especially more difficult to deal with. I worked in a commercial greenhouse which used drip watering for all their hanging foliage plants. The system that was used was called Water Chain by Aquatic.

In this system, the drippers are glued to the tubing compared to just connecting them. The permanent connections made it easier to run normal pressure from the household waterline without fear of the line bursting at the connections. Once the plants were hung on the greenhouse purlins, the space between was measured and tubing was cut. The drippers were attached and this time I laid the line on the *Nepenthes* medium surface to reduce splashing that occurred when the dripline was attached to the purlin and allowed to drip down to the plant as the case in the commercial greenhouse.

By regulating the water pressure by a flow restrictor, I could attach the drip system to a solenoid and a clock to automatically water my plants. This allowed the medium to soak up the water before the duration was completed otherwise an unrestricted flow would just rush through the pot only wetting the center which restricts root development and possible drying out.

I use household tap water with a carbon filter with no ill effects on the plants. This is done when the tap water is warm enough not to shock the roots. In winter when the tap water comes out ice cold, I will switch the line to a manual faucet with a hot water connection. With the drip line in operation, watering makes it easier to travel in summer without worry.

Kim Sikoryak (8 Mariano Road, Santa Fe, NM 87505).

I read with interest the article by Phil Sheridan on *Sarracenia alata* in the December 1991 issue of CPN. I was surprised to find on page 104 that this species was described as "...introduced...in the Big Thicket National Preserve" in Texas. As an interpretive naturalist with the National Park Service, as well as a long-time ICPS member, I know that it is definitely not the policy of the National Park Service to introduce plant or animal species in parks. I called the preserve and spoke with several of the staff. The following story emerged.

Sarracenia alata is a naturally occurring species in the Big Thicket. It is found in lower, wetter habitats there, primarily in the park's Turkey Creek unit. In the late 1970's, the park was looking at reestablishing a more natural fire regime by prescribed burning, since natural open areas were being lost to shrub encroachment due to human suppression of natural fire. As insurance against the possible adverse effect of fire on the remaining *Sarracenia alata* stands, Geraldine Watson, then the park's botanist, relocated several clumps to some of the other units in the Thicket. A secondary aim of this activity was to test the survivability of the pitcher plant in other habitats in the park to learn more about its requirements and possibly determine if the plant was more widespread formerly. All plants so relocated were from stock within the Thicket, so no outside genetic stock was introduced. Today, the fire program has recreated more normal ground cover in the Turkey Creek unit, the pitcher plants have shown that they tolerate prescribed fire, and the relocated clumps of *Sarracenia alata* continue to be observed for long-term survivability.

Special Notice

For those people who like to grow and study *Pinguicula* there is a new publication that discusses all aspects of this genus. For more information on this specialized newsletter, write to: Ron Mudd, 10 High St., Wymington, Nr. Rushden, Northants. NN10 9LS, ENGLAND, UK. The plan is for two issues to be produced per year at a cost of £1.00 (or \$ equivalent) per issue. The name: The International Pinguicula Study Group Newsletter, first published in April 1992.

Book Sources

Future publication

Guide to Carnivorous Plants of the World. Gordon Cheers. Harper Collins, 1992, Sydney, Australia. 208 pp; 180 illustrations. \$45.00.

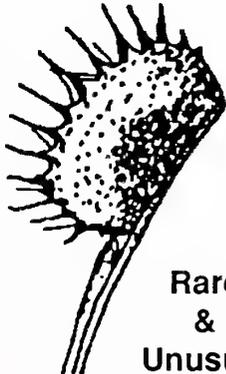
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Mechanisms of Trap Movement II: Does *Aldrovanda* Close by a Turgor Mechanism? A Question of How Much, Where, and When

By S.E. Williams
Department of Biology
Lebanon Valley College
Annville, PA 17003

Of the three genera of the family *Droseraceae* with movements involved in their trapping mechanisms *Drosera* tentacles and *Dionaea* traps are reported to close by a mechanism involving a relatively rapid increase in wall plasticity on the abaxial (back, outer) side of the tentacles or lobes (Williams, 1991). Strangely *Aldrovanda* trap lobes which are very similar to *Dionaea* lobes are reported to move by a rapid loss of turgor in the adaxial (inner) side of the trap lobes (Ashida 1935, Iijima and Sibaoka, 1981, 1982, 1983, 1984). In their recent book *The Carnivorous Plants* (p.104) Juniper, Robins and Joel state "Studies on *Dionaea* and *Aldrovanda* have led to two contradictory views being put forward as to how rapid movements occur in these species." This is not quite true since the two mechanisms are not mutually exclusive and it is possible that both a turgor loss on the adaxial (inner) side and acid growth on the abaxial side could occur together and cause the movement in either plant. The evidence for acid growth in *Dionaea* was reviewed last time (Williams, 1991). There is evidence against turgor loss as a mechanism in *Dionaea*. The abaxial (outer) side expands during opening and loses turgor while the adaxial (inner) side shows no significant change in size and remains turgid¹. The evidence in *Aldrovanda* is more equivocal and requires careful quantitative scrutiny.

Iijima and Sibaoka (1983) give the following evidence:

1. Experiments using rubidium ion as a marker for potassium ion indicate a loss of 0.25% of the trap potassium during an action potential. Loss of potassium and chloride ion is the cause of the turgor loss in the *Mimosa* pulvinus, guard cells and other well studied turgor mechanisms of plant movement.

2. Experiments using rubidium ion indicate potassium is taken up by the traps at a greater rate after trap closure in reopening traps than it is in unclosed traps. This would also be expected in a turgor controlled trap.

3. Traps placed in 200 mM mannitol-APW² will produce an action potential when stimulated but will not close. When placed back in a very dilute ionic solution (APW) these traps still remained open. Iijima and Sibaoka (1983) state that this shows that "no ion leakage from the active motor cells was caused by the action potential in 200-mM mannitol-APW which is nearly isotonic to the inner and outer epidermal cells in the motor zones." They also state that "This fact strongly suggests that the solute leakage from the active motor cells necessitates the pressure inside the cells and is induced by bulk flow, not by diffusional flow, between the vacuole and the outside of the cell wall."

Atomic absorption spectrum measurements of K⁺ indicate that there is a concentration of 49.5±4.7 mM (about 50 mmole/liter K⁺) in the traps (Iijima and Sibaoka (1985). Measurements of trap cell volume indicate that it is about one µliter (= 1.0 mm³) (Iijima and Sibaoka, 1983) a value that seems reasonable when compared to the dimensions of the trap. From these values it can be computed that there is about 50 nmole of K⁺ in a trap.

$$50 \text{ mmole/liter} \times 10^{-6} \text{ liter}/\mu\text{liter} = 50 \times 10^{-6} \text{ mmole}/\mu\text{liter}$$

$$50 \times 10^{-6} \text{ mmole}/\mu\text{liter} \times 10^9 \text{ pmole}/\text{mmole} = 50 \times 10^3 \text{ pmole}/\mu\text{liter} \text{ or } 50 \text{ nmole}/\mu\text{liter trap}$$

Iijima and Sibaoka (1983) report a loss of 374 pmole of K^+ from a trap based on their Rb^+ measurements. This is about 0.75% of the trap potassium as measured by the atomic absorption spectrophotometer. It is more than the 0.25% estimated from rubidium measurements alone (Iijima and Sibaoka, 1983).

Since the active area of the trap is about 0.38 cm^2 (Iijima and Sibaoka, 1983) the loss per unit area is:

$$(374 \text{ pmole}/\text{trap}) / (0.38 \text{ cm}^2/\text{trap}) = 984 \text{ pmole}/\text{cm}^2 \text{ } K^+ \text{ per trap}$$

An approximately equal amount of anion would also be lost from the trap. It can be estimated that the total solute lost during trap closure is at least twice as much as the potassium loss:

$$2 \times 374 \text{ pmole} = 748 \text{ pmole solute}/\text{trap}$$

$$2 \times 984 \text{ pmole}/\text{cm}^2 = 1968 \text{ pmole solute}/\text{cm}^2$$

If all loss is through the 0.06 cm^2 motor cells (Fig. 1, Iijima and Sibaoka, 1983) we can compute:

$$(748 \text{ pmole solute}/\text{trap}) / 0.06 \text{ cm}^2 = 6,233 \text{ pmole of } K^+/\text{cm}^2 \text{ or } 12,466 \text{ pmole of solute}/\text{cm}^2$$

Let us now examine each of Iijima's main points using both his assumption that all K^+ loss is through the cells of the motor zone and a second model where the K^+ loss is assumed to be evenly spread over the active area of the trap.

1. Potassium release during the action potential and trap closure. A single action potential will result in the closure of *Aldrovanda*. All action potentials involve the passage of specific ions across the membrane — that is the mechanism by which action potentials occur. Typically both plant and animal action potentials lose potassium ion during the recovery simply as a part of the signal producing process. The loss of potassium would be expected regardless of the mechanism of trap closure. There are two questions that arise:

- Is the K^+ loss during the action potential just that expected from the action potential or is there another mechanism of K^+ loss?
- Regardless of the mechanism, is enough K^+ (and accompanying anion) lost to cause a turgor change in the motor cells sufficient to cause trap closure?

Iijima and Sibaoka (1983) state "It is unlikely that as much as 0.25% of the total potassium can move from the cells during an action potential." Presumably they mean by this that the mechanism of the action potential triggers a flow of potassium ions from the trap that is greater than that to be expected from the action potential itself. But is it "unlikely that as much as 0.25% of the total potassium can move from the cells during an action potential"? Assuming all potassium movement will occur through the motor cells, Iijima and Sibaoka (1983) compute a potassium flow (outward movement) of $6,200 \text{ pmole}/\text{cm}^2$ across the membranes of the cells of the motor zone of *Aldrovanda* during an action potential. If they had assumed the flux was across the entire active part of the trap, as an action potential would be expected to do, their figure would have been $984 \text{ pmole}/\text{cm}^2$ (Fig 1). Since Oda (1976) measured an outward flow of $1,777 \text{ pmole}/\text{cm}^2$ across the membrane of *Chara* (a giant algal cell) during an action potential, it is unnecessary to postulate any mechanism beyond the loss of potassium during the action potential to account for the estimated flux since assuming an efflux of potassium where one is expected from the action potential gives a value smaller than that measured in another plant. There is no reason to suppose that it is unlikely that the

efflux due to the action potential can account for the potassium that leaves the trap during closure.

The question of whether the turgor change in the motor cells resulting from K^+ loss is sufficient to cause movement is the one of major interest. Iijima and Sibaoka (1985) measure 117 meq of chloride ion in trap lobes. Allowing for 117 meq of positive ions to balance the charge there are at least 234 mosmole of solute/liter in the cells. There are likely to be at least 250 mosmole/liter. The osmotic pressure in such a cell would be:

$$\pi_{\text{cells}} = cRT = 250 \text{ osmole/liter} \times 24.8 \text{ liter-bar/mole} = 6.2 \text{ bar}$$

Another estimate of the osmotic pressure can be computed from the amount of mannitol APW that Iijima and Sibaoka (1983) report is isotonic to the trap (200 mosmolar mannitol +14.5 mosmolar APW) would show:

$$\pi_{\text{cells}} = cRT = .2145 \text{ osmole/liter} \times 24.8 \text{ liter-bar/mole} = 5.3 \text{ bar}$$

A bar is a metric unit of about one atmosphere, so the cells would have about 6 atmospheres of osmotic pressure.

Iijima and Sibaoka (1983) assume that all the loss of K^+ would be through the motor cells in their calculations (Fig. 1). This results in a high estimate for the amount of turgor lost by the motor cells since these cells compose only 3.2% of the trap volume. A second estimate assuming equal loss from all cells results in a far lower turgor loss by the motor cells. Without knowing from which cells the K^+ is actually lost, it is impossible to say what the actual turgor change in the motor cells is but the true value is likely to lie within the range bounded by these two values.

Assuming equal distribution of loss of trap potassium and an accompanying anion would result in a drop in concentration of:

$$\begin{aligned} &748 \text{ pmole solute/trap} \\ &748 \text{ pmole}/\mu\text{liter} = 0.748 \text{ mM} \end{aligned}$$

This should result in a change in osmotic pressure of:

$$\pi = cRT = 7.48 \times 10^{-4} \text{ osmole/liter} \times 24.8 \text{ liter-bar/mole} = 0.0186 \text{ bar}$$

The change in concentration during closure due to the loss of potassium and a balancing charge should result in the loss of about 0.02 atmosphere of osmotic potential in a cell with about 6.0 atmospheres of osmotic potential. If we make the assumption that all the potassium is lost from the cells of the motor zone we can estimate that the internal osmotic potential change will be about 31 times larger by using Iijima and Sibaoka's (1983) estimate that the motor cells constitute 3.2% of the volume of the trap. This would give a value of 0.62 bar, a change of about 10% in the osmotic potential in the motor cells and clearly more than enough to cause a substantial turgor change in the motor cells. In both instances the osmotic pressure ($= \pi_{\text{in}} - \pi_{\text{out}}$) is influenced by the buildup of the potassium ions lost from the cell outside the cell so the values must be considered the maximum pressure change that could be expected under the circumstances measured. Unfortunately there is no evidence as to which cells are losing the K^+ . The loss could be nearly equal from all cells, in which case the K^+ loss from an action potential can easily explain the results, or the loss could be primarily (50 or 75%) from the motor cells, in which case a substantial turgor change would be expected. Even if the loss of K^+ is evenly distributed and due entirely to the mechanism of the action potential, a turgor event cannot be ruled out. In *Chara* internodal cells, bathed in APW, the chloride and potassium ions lost during an action potential cause an 0.38 to 0.55 mm decrease in the length of 70 - 110 mm long cells (Oda and Linstead, 1975). The much larger surface to volume ratio of *Aldrovanda* trap cells would enhance this effect. In the delicately balanced system of the *Aldrovanda* trap these osmotic changes may be enough to cause adequate water movements to trigger closure by Ashida's (1934)

mechanism. It is possible, but not by any means proven, that the initial phases of *Aldrovanda* trap movements result from a turgor mechanism

2. Potassium uptake during the reopening of the trap. The increased uptake of potassium during the reopening of the trap is consistent with what would be expected from a turgor mechanism since restoration of the solute with its accompanying osmotic pressure would cause water to move into the cells and restore turgor. An increased uptake of potassium during the reopening is also consistent with what would be expected from an acid growth mechanism since the expanded cells on the outer lobe would lose turgor and ordinary homeostatic mechanisms which control turgor would be expected to restore turgor to these cells by taking up additional ions from the environment. Here we have data that is expected for both mechanisms and does not distinguish between either of these hypotheses. The increased rate of uptake of potassium after closure is, however, not consistent with a turgor gain mechanism such as that proposed by Brown (1916) for *Dionaea*.

3. Traps placed in a nearly isotonic medium will not close when stimulated to produce an action potential. According to Iijima and Sibaoka (1983) a 215 mM solution is "nearly isotonic" to traps. Triggering an action potential in this solution will not cause trap closure. This observation is consistent with all three hypotheses. If water can not move into or out of trap cells, movement by both turgor gain and loss are impossible. Wall loosening expected in the acid growth mechanism could occur but the cell expansion that causes the movement in this mechanism could not. The observed result is predicted by all three hypotheses and thus the experiment fails to distinguish between them.

When transferred back to a dilute ionic solution (APW) immediately after triggering an action potential in the 200 mM mannitol-APW solution which prevents closure, the traps still remained open. This is a result that is hard to explain with any of the hypotheses. A turgor loss mechanism by rapid diffusion of potassium and an anion (presumably chloride) through specific channels in the membrane should not be prevented by mannitol.

The ion flux should still occur but without the water movements since the effect of the osmotic pressure is rendered a negligible part of the water potential difference which would drive the water movement. Restoration to the dilute solution (APW) should allow the water movement and closure. A parallel argument would hold for a turgor gain mechanism. The growth mechanism should also close after moving the trap to a dilute solution since the water can move into the cells with loosened walls and result in the expansion of the trap. Oddly, we are faced here with a situation where none of the hypotheses seem to explain the results. Ashida (1934) had reported similar results with sugar solutions but also noted that both plant's traps remain shut if placed in sugar solutions after closure. This data is consistent with the acid growth model but not with either turgor mechanism.

Iijima and Sibaoka (1983) suggest that their results from experiments with mannitol-APW solutions are consistent with the hypothesis that there is a bulk flow from the vacuole of the motor cells to the outside of the cell, and that this causes the movement rather than a diffusional flux of ions. They state that this flow must be dependent on pressure being maintained inside the cells. This may be so, but further work needs to be done to test this new fourth hypothesis. An unknown pressure-dependent component could be hypothesized for any of the other three to explain the results, i.e., either the potassium channels or the hydrogen ion pump is pressure-sensitive in its response.

Iijima and Sibaoka (1983) have added a hypothesis to the list of possible mechanisms of *Aldrovanda* trap closure and they have provided useful data that indicate a possible role for K⁺-driven turgor loss but they have not convincingly demonstrated by what mechanism the trap moves.

In work communicated to me in a letter but never published, Toshio Iijima found that the outer epidermis of the motor region of *Aldrovanda* traps expands 15% and the inner epidermis shrinks by 17%. This would support the action of a combined turgor response and growth response. In his letter he also reported responses to neutral buffers similar to those seen by Alan Bennett and me (Williams and Bennett, 1982) but reported complications with the experiments with acetate buffers due to triggering of action potentials and lowering of cell ATP by acetate. He correctly pointed out in his letter that the closure of *Aldrovanda* trap is 10 to 20 times faster than that of the *Dionaea* trap and that the movement begins when the action potential is still in its fast rising phase. Ashida (1934) measured movement as soon as 80 msec after a generalized electrical stimulus, with substantial movement by 90 msec after the stimulus, while Iijima and Sibaoka (1981) show the action potential's rising phase lasts 200 msec. During this phase a calcium influx (Iijima and Sibaoka, 1985) and possibly a chloride efflux and the beginnings of a potassium efflux are occurring if the mechanism is similar to that in *Chara* (Oda, 1976). It is in this very early period that a turgor loss from the outer motor cells could release a movement that is largely like triggering a spring trap. Ashida (1934) noted that the outer epidermis is undulated as if it were a coiled spring. After closure, the midrib reverses its position and the undulations disappear. The *Aldrovanda* trap may be "cocked" and it may "spring" when a relatively small change occurs —presumably in the inner epidermis. In *Dionaea* the lobes reverse from a convex internal curvature to a concave internal curvature during closure. This produces a mechanical amplification of the movements but the degree may not be nearly as great as in *Aldrovanda*.

Ashida (1934) divided *Aldrovanda* trap closure into "quick phase" closing, "slow phase" closing and trap "narrowing". He believed the quick phase closing was due to turgor loss and that narrowing was due to an increase in the plasticity of the outer walls of the trap. He had qualitative evidence for each mechanism involving observation of the relative degree of undulation of the trap epidermis. He did not clearly specify the mechanism of slow phase closing, but most of it occurred between 0.2 sec and 30 sec, declining to nearly nothing within 60 sec. This is about the rate at which the *Dionaea* trap closes. Perhaps the "slow phase" movement of *Aldrovanda* closure is caused by wall loosening by an acid growth mechanism similar to that in *Dionaea*. Both plants would then have the same physiological events going on in their cells but in *Dionaea* the osmotic effects of ion loss during the action potential may be negligible in their effect on the movement.

Toshio Iijima, Takao Sibaoka and Joji Ashida have advanced our understanding of *Aldrovanda* trap to a point where its electrophysiology and trapping movements are among the best understood of any of the carnivorous plants, partly because this plant's aquatic nature lends it to this type of study and largely because of a considerable amount of incredibly careful and exacting work. This discussion only deals with one important phase of the work of these men.

Thanks are due to Dr. John D. DeGreef of Liège, Belgium and Dr. Donald Dahlberg of the Chemistry Department, Lebanon Valley College for reviewing the manuscript.

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¹ You can test the turgidity yourself with a probe, such as a ballpoint pen. Push the probe gently into the epidermis of each side of an open trap. If your plant is well watered it will be turgid (hard). Close the trap by stimulating the hairs twice. Probe the trap soon after closure. It will be flaccid (soft) and your probe will sink in a bit. Cut the trap down the center and probe the inside. It will be turgid. This is what the acid growth mechanism predicts but it is the opposite of what a turgor mechanism would predict.

² Mannitol is a sugar alcohol often used in experiments on osmotic pressure. APW stands for "artificial pond water" and is often used in electrophysiological experiments on freshwater and terrestrial plants.

A Letter From Sierra Leone¹

Dear CPS:

I hope all is well, I hear there's been quite a hard winter, not too many casualties I hope.

After a long, *Triphyophyllum peltatum* filled silence, I write again (I would like to think more coherently than my last tropically stunned communication).

I have been in West Africa some months now, although my time in 'Tome' land (the plant's name in Mende - one of the local tribes - and in fact the only one of S. Leone's ten or so that has a word for it) is split into two by a Christmas gadabout in Mali. Before leaving the country for Christmas then, I went around bush paths, small villages (they are spiders with leg paths) going nowhere in particular enquiring about the plant. This was some adventure in itself - in villages in the south-western part of the country, it is not widespread and so only the elders who had made studies of plants, usually medicine men or witch doctors, knew about it, and my investigations were often met with some difficulties - sometimes it would be growing in sacred society bush, which a non-member cannot enter ("coco jinoku, mahanhoo mahmoo gonge" is a Mende proverb which means something like "We who are in the Society and know, are not going to tell you, so nur nur-ne nur nur", dispensed freely to those who ask too many questions). Another problem was a fierce old man with a bald head save for a few white popples of hair, who demanded in payment for the knowledge of a medicine man, that I should marry his daughter.

The first time I did see the plant I was unimpressed - a blackish liana twizzling up into the sky via an ant-covered giant tree. Somewhere up there I fancied, just maybe, I could see the characteristic tendrilled leaves; climbing was out though.

As I moved further eastwards, the plant became more common, as far as I could tell as the surrounding bush changed from heavily cultivated farm bush type to predominantly old secondary forest with patches of farms and patches of primary forest. It was about here that people would proudly announce that they had seen "Tome" on their farms - and show it to me before cutting it down with surrounding trees ("brushing") to make room for next year's rice crop.

All I saw, despite huge searches, was the mature lianas, or the seedling in the first growth stage. I began to remember that many botanical hoaxes have concerned carnivorous plants, but dutifully planted a nursery bed by a stream to return to at a later date! (Actually, I don't know where I remembered that from, I probably made it up. It's the sun you know)



A young plant of *Triphyophyllum peltatum*

After Guinea and Mali on horseback, I returned to Sierra Leone in late January through her eastern earhole, Koinda and knew things were looking up. After crossing the border/river without the necessary squiggles and stamps in my passport (corruption, and this time I really had run out of local money at the border so I couldn't have paid the fairy-tale fee even if I'd wanted to) instead of sending me back the customs officer took me to his farm in the full moon and we enjoyed freshly tapped palm wine. Bubbling, like yeasty lemonade it is very refreshing. The evening was only tainted by a whiff of engine oil - the palm wine (or poio) came from a 5 gallon oil can. Each individual tree is tapped and the stuff collected in a calabash on a vine - you scale the tree and let it down to your friend and he drinks half and puts half into the pot - or something like that. Later in the Gola forest, the kindly but very pious Muslim man who had received me decided I was drinking too much so I should have my own palm tree to take care of. Quite a challenge. I stayed in that village quite a while. It was here that I saw my first huge chunk of primary forest - an infinite and beautiful cathedral inside - and here on the edge I first saw *Triphyophyllum* in the carnivorous stage. Not just one plant or two, but I would guess about a hundred, no doubt in the hinterland of a vast liana, these seedlings were of different sizes (so I presume ages) ranging from about 10 cm high to about 50 cm, nearly every one with at least (and in fact usually) one betentacled glistening wire. I never have seen more than three trapping wires alive at the same time per plant, though there are often dead, dried up ones, hanging down. This suggests that perhaps the carnivorous phase can be quite long-lived. The wires seem to unfurl in a similar manner to *Drosophyllum* and are in fact I believe a specialized form of midrib of the ordinary leaves, judging by an

intermediate form I spotted one day. Interestingly enough, I have seen more plants in old secondary forest than I have in primary, so just maybe it is not as endangered as it could be, since virgin forest now covers only 4% of the land area of this country, compared to 95% two hundred years ago. (I think these are the numbers I was told, but I don't swear.) Secondary forest, the most plentiful kind in that area now, differs in that there are few big big trees, and consequently without the high canopy of the vegetation inside is much more dense.

I am returning to England early April with hopefully, some specimens. I have collected seed, pressed flowers and leaves and am in the process of obtaining the necessary documents from the Sierra Leone Government to bring back a live specimen. I'm afraid I'm a bit out of touch with what is going the CPS currently - I forgot to join last year and this year so far I have been kind of out of it - if "we"/you have a conservation collection yet then I think *Triphyophyllum* would be a good candidate.

I learnt early on that the road to Tome is cultural sensitivity and that in itself has taught me a huge amount and brought literally months of tremendous enjoyment. Come to "sunny Salone"!

Best wishes,
Jonathan

PS I'm at the foothills of the country's highest hill at the moment. Mt. Bintumani, where there are supposed to be some epiphytic Utrics. Eyes are open. Also seen plenty *Genlisea africana*. See you soon.

PPS I'm not a botanist - if any of this is rubbish please add this disclaimer!

¹ Reprinted with permission from *The Carnivorous Plant Society Journal*. Spring, 1991 (Vol. 15 #1)

Announcement

In March, 1992, CITES met in Kyoto, Japan and placed *Dionaea* in Appendix II. Appendix II species are not deemed presently threatened with extinction but could become so unless their trade is regulated. Import permits are not required. However, export and reexport permits are required from the export country certifying that the shipment will not place the plants in a threatened status. This rule applies to whole plants as well as plant parts.

No Longer Accepting Orders!

Hummer's Acid-Wetland Flora
1705 N. Quebec Street
Arlington, VA 22207

Carnivorous Plants of the Brazilian Cerrado

By Fernando Rivadavia
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During my winter vacations of July 1991, I visited two areas of Brasil where savanna-type vegetation, called cerrado, predominates. It consists mainly of grasses and stocky, fire-resistant trees (which are more or less numerous, depending on the area), but along rivers, the vegetation is similar to rainforest. Winter is the dry season and is characterized by hot, dry, sunny days and cool, moist nights. Termite mounds are very common in cerrados and in some places become quite crowded.

I first went to the city of Cuiabá (Mato Grosso state), in the northern Pantanal Basin. I would be staying 5 days with a CP collector I contacted 2 weeks before, Marcos Cardoso. I was anxious to explore that area for CPs, especially the Chapada dos Guimarães, a vast, cerrado-covered, tepui-like formation which rises around 700 meters from the Pantanal Basin to an altitude of 850 m. Chapada is the Portuguese word for tepui. This chapada is located around 60 km east of Cuiabá and as you approach it by car, you notice the true dimensions of the rock wall extending along the horizon. A magnificent view! We went twice to the Chapada dos Guimarães and found lots of CPs.

At the first stream we stopped by, we found yellow-flowered *Utricularia nana*, lavender *U. costata* (both with flower scapes only a few centimeters tall), and also an *Utricularia* with round leaves (which, weeks later, we figured out was a *Genlisea*, either *G. repens* or *G. pygmaea*) all growing on the sandy stream banks. A yellow-flowered, semi-aquatic *Utricularia* grew affixed to rocks in shallow, running water. All these CPs were found in an open area of the stream, without the shade of trees. The following day, we explored an area of the stream shaded by thick vegetation, where we found *U. pusilla* and *U. amethystina* or *tricolor* growing on semi-shaded, mossy stream banks.

At the second stream we stopped by on the first day, we found more *U. neottiodes* and *U. nana*. There were also red-leaved *D. communis* growing in sandy-clayish soil on the stream banks. These reached 2 cm across and scapes were found, shedding fusiform seeds. In cultivation they produced white flowers.

Our next stop was a magnificent waterfall which drops 70 m into a forest-covered valley surrounded by the cerrado-covered chapada. We climbed down to its base and found *U. subulata* among mosses on the cliff, receiving spray from the falls, next to a curled-up, poisonous snake we call "surucucu". We returned here the next day and headed for what looked like stream beds in nearby grassy hills. No streams were found (though they probably do form in the rainy season) but depressions were more humid and we soon found *Drosera* up to 2.5 cm in diameter growing under the semi-shade of grasses in soil consisting of broken bits of rock plus sand. In fact, it was so rocky that we had difficulty digging into it to remove a few plants. At first we thought they were *D. communis*, but then we came upon plants in bloom. The pink flowers were up to 1.2 cm across, borne on extremely hairy, yellow-greenish scapes up to 18.5 cm high. All this matches up with the *D. pumila* collected in the state of Mato Grosso and described by E. Santos in *Bradea* magazine. The only difference is that she describes scapes only 4.5 cm tall. Flowers were not described well and seeds not even mentioned. I heard that few plants were analyzed, and badly too. In Schlauer's nomenclatural synopsis

of CPs, *D. pumila* is considered a synonym of *D. colombiana*. I have not read anything by anyone invalidating *D. pumila*, but I'm sure this species I found must be the same one Santos studied. Anyway, with this *Drosera* we found *Utricularia* peduncles reaching 15 cm in height bearing tiny, white flowers with a yellow blotch at the base of the lower lip. I have not been able to identify this species yet through Taylor's monograph. Further study is needed to determine if this is a new species or not. These two species were seen again near a cave we visited, growing in a similar habitat, but spread all over the hillsides and not only along water depressions. My guess is that they depend heavily on condensation as a water supply during the dry season. On the way to this cave, we stopped by wet slopes on the roadside and found *Drosera* without flowers (might be *D. communis*), leaves of *U. hispida*(?), and more *U. subulata*.

Leaving the cave, we found a muddy area on the roadside where there were reddish *Drosera* resembling small *D. intermedia* with fewer leaves growing on "islands" slightly above the water-drenched muddy sand. They might be *D. communis* under different conditions, but we are not sure. Around them, grew *U. simulans* (with fringed calyx lobes which reminded me of a VFT) bearing 1-3 flowers clustered at the top of scapes up to 10 cm tall. Near these CPs, on higher, drier but not rocky ground we found more *D. colombiana* with typical hairy scapes.

So these were the CPs found at C. dos Guimarães on July 12 and 13, 1991. On July 25, I left S. Paulo for the Parque Nacional das Emas in southern Goiás state, bordering the states of M. Grosso and M. Grosso do Sul where I stayed 5 days, until the night of the 31st. This national park got its name because of the abundance of *Rhea americana* which we call emas found in the area. The terrain varies between 800 and 1000 m, and the park is famous for its fauna, which includes rheas, giant anteaters, capybaras, deer, macaws, toucans, tapirs, foxes, plus many others which can be seen while travelling on the dirt roads which cross the park. It was created as a park in 1961 but reduced by 500 km² in 1972 and the present 1318 km² are nearly abandoned by our government even though it is our largest and most important reserve. Cerrados used to cover around 25% of the area of Brasil but are now restricted to 4 semi-protected parks which represent only 0.01% of the original range, thus being more endangered than the Amazon rainforest. The rest has nearly all been cleared for cattle ranches or soybean farms. A barbed-wire fence financed by the WWF in the 1970's encloses the park but isn't enough to hold in animals which seek food in surrounding farms and are thus often killed. These farms cause various problems such as pesticide contamination, erosion, and fires.

We arrived after sixteen bus hours, at 6 AM on the 26th. When the unloading was done, we went to see the sunrise at a nearby river. I soon saw *U. nigrescens* with yellow flowers on long scapes and *U. subulata* growing in sandy-clayish soil in a treeless area next to the river. While having breakfast, I found a few reddish *Drosera* growing among the Utrics. I collected and then discovered that *U. subulata* was really *Genlisea*! I ran back to the river site and to my surprise found *Genlisea* and *Drosera* nearly covering the ground, which I did not see earlier due to the diffuse sunlight. They seemed to have no preference for the higher, drier ground or the lower, wetter areas as some *Genlisea* even grew underwater! The *Genlisea* had leaves up to 1.5 cm long and 5 mm wide at the tip, while their flower scapes reached 8 cm in height and each had a yellow flower around 6 mm long and 4 mm wide but as many as 3 seed pods. The largest *Drosera* were 3 cm across and most were beginning to flower. The flower scapes were up to 6 cm in height and had white flowers around 8 mm in diameter. Fusiform seeds were shed from this round-leaved species which is probably *D. communis*. Two more Utrics were found here: yellow-flowered, aquatic *U. gibba* growing in a muddy puddle and *U. tricolor* with dark-green, rounded leaves. That afternoon, while walking through flooded grasslands next to forests bordering another river, I saw more *U. tricolor*, *U. gibba* and large *Genlisea* (*G. aurea*?) with strap-shaped leaves up to 2.6 cm long and 5 mm wide.

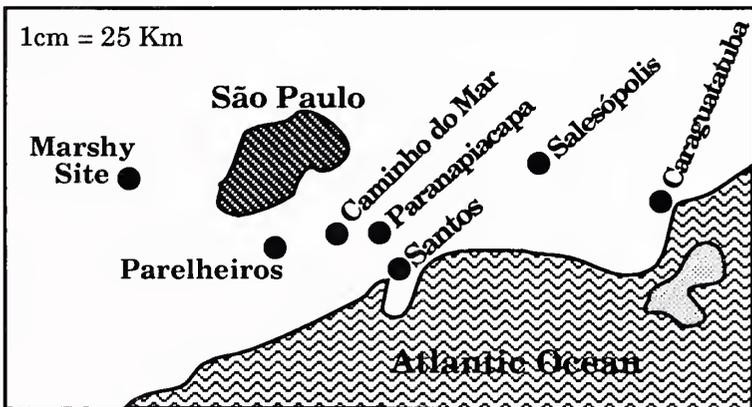
The second day, we went to the source of the most important river in Brasil; the Araguaia, which flows north all the way to the Amazon Basin. Returning early that day, I went CP hunting with a friend. We wanted to search a forest-covered riverside for Utrics. On the way, my friend pointed out some *Drosera* which I was nearly stepping on (I have the bad luck of being a bit color-blind for red!). My eyes almost jumped out as they set on the weird sundews! I froze, speechless, as I noticed we discovered a NEW SPECIES OF *DROSERA* !! It is a miniature of another Brazilian sundew, *D. chrysolepis*, or like the pygmy, *D. scorpioides*. With this *Drosera*, grew the yellow-flowered *Genlisea* and *D. communis*. I found one other place where the new *Drosera* grew, at a river source we visited the next day where I also saw *U. nana*, *U. nigrescens*, *U. subulata*, and *Genlisea*. This new *Drosera* was very abundant locally at both sites and grew in sandy soil mixed in with some clay. Like *D. chrysolepis*, it also forms stems which hold the plant erect or become prostrate, though *D. chrysolepis* is 10 times larger. The longest stems were 3.5 cm in length, but it was obvious that the old end of the stem rots away as the plant grows. The greenish-red leaves reached 1.6 cm in length with lamina 7 mm long and 1 mm wide. The flower scapes are up to 12.5 cm tall and bear white flowers around 8 mm in diameter. As many as 4 flower buds are produced on each scape and seeds are fusiform. Both sites faced east and received no sunlight after 2 or 3 PM (July is winter when the sun was low). Taxonomists at my university (University of São Paulo) also believe it is a new species, though it might have really been discovered 40 years ago! There are 2 badly-preserved, unidentified *Drosera* without flowers in the university's herbarium which were collected in the early 1950's near Goiânia, around 400 km NE of the P.N. das Emas. I believe they are the same species as the one I found.

On the 3rd day, we visited the source of the two rivers. I saw the new species at both rivers growing in sandy soil under the heavy shade of grasses between 60-80 cm tall. Also, I saw *D. communis* growing in the fluffy, broom-like grasses in a wet area where it is commonly found. These sundews are mostly greenish in color, with rosettes up to 2 cm across. They have not yet flowered in cultivation. The last two days here were not very successful and I found the new species with *U. subulata*. I did find extensions to the original *U. gibba* and *U. tricolor* sites in floodplains next to the river. This wraps up my trip to the P.N. das Emas!

Adding up all the CPs seen in the Brazilian cerrados on these two trips, at least 17 species were found and maybe lots more. This was surely the most fruitful winter vacation I ever had! A few days after I returned to S. Paulo, a friend told me he collected a *Drosera* species in another cerrado area in the state of Goiás. They ended up being a species I was expecting and hoping to find on my trips that winter: *D. sessilifolia*! They had leaves around 1.5 cm long and 1 cm wide. One had a flower scape 26 cm tall with 15 flower buds and sepals covered with red hairs. Along with *D. sessilifolia* were a few *D. communis* (?) with leaves 1.8 cm long (1 cm petiole), plus 1 or 2 species of Utrics. Unfortunately, they arrived in bad conditions and none survived. Soon after receiving these plants, I got a box from Marcos with 2 yellow-flowered *Genlisea* species he found at the Chapada, growing in a muddy area by a stream. I identified them as *G. aurea* and *G. repens*, and I noticed that some *Genlisea* from P.N. das Emas had hairy flower scapes while others had smooth scapes. I found out that there were 2 species: *G. repens* and *G. pygmaea*! They grew together on the riverside and all I noticed was a slight difference in leaf size! So *G. pygmaea*, with smaller leaves, grew on higher ground and *G. repens*, with larger leaves, grew in wetter ground, even underwater. Six months have now passed and Marcos found more interesting CPs on other trips to the Chapada, maybe another new *Drosera* species. But these things will come out in a future article, after careful observations in cultivation and maybe after I return to the Chapada. So to end this article, I would like to thank friends who helped me find CPs at the P.N. das Emas and Marcos and his family for the hospitality during my stay at Cuiabá and for the confidence in inviting a total stranger to stay with them.



São Paulo City Area





D. colombiana. Chapada dos Guimapães



Drosera colombiana. Chapada dos Guimapães



U. nigrescens. P.N. das Emas



Genlisea repens. P. Nacional das Emas



Genlisea pygmaea. P. Nacional das Emas



D. communis. P.N. das Emas

A Carnivorous Plant Tour of South America Part One: Trekking Through the Tropical Northeastern Countries.

By Randy Lamb
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This quest for adventure was a bare-bone budget dream trip planned since graduating from university. My trip encompassed most of the continent and even though it was not designed specifically as a search for carnivorous plants, there was ample opportunity and time to investigate such matters.

Venezuela

Soon enough I found myself in the thick of things outside a Venezuelan airport negotiating with some trouble a taxi ride to the city. I knew no Spanish at all at that point and I had no choice but to learn quickly if I was to survive the next few months!

Initially I spent only a few days in Caracas and then set off on an overnight bus ride towards "La Gran Sabana". After a bumpy and sleepless night I dozed off at the most inopportune time and missed my stop at Ciudad Bolivar. When I realized what had happened, and finally managed to get off the bus, I was on the Panamerican Highway a few kilometres beyond the town. In total darkness, being serenaded by nocturnal insect and animal sounds, I began my walk back until miraculously a taxi of sorts appeared, piercing the night with its one working headlight and the rumble of its ailing muffler.

The following day I was on a flight over the Gran Sabana enroute to Santa Elena. We descended through the cloud cover in time to see a series of massive tepuis, the highland's famous table-top mountains, with waterfalls falling down their steep vertical sides. It was truly awe-inspiring seeing these partially cloud shrouded "islands in time" standing over the steamy jungles below as we flew between them.

Santa Elena turned out to be a friendly bustling frontier town. There it was possible to arrange treks to the tepuis to see the rare plant treasures such as *Heliampora* and *Genlisea* that grew on them. The organized tourist treks required either large groups of people or large amounts of money and I had neither. Although I found two Englishmen willing to accompany me to Mount Roraima, there were major time problems involved. To acquire proper government permits, obtain vehicles, get to the tepui and then do the climb would have taken weeks. Those extra weeks would have cost me a boat trip down the Amazon River and New Year's in Rio de Janeiro, so I pressed onwards. I consoled myself by hiking the countryside, hills and the Pan American Highway around the small town finding orchids, snakes and giant ants, but no CP.

Brazil

Brazil, or rather Brasil as the Brazilians spell it, introduced itself quickly as I bused down to and across the Amazon basin from Santa Elena. In Manaus I made arrangements to go on a jungle trek but found nothing in the way of CP. More than likely the large seasonal river height fluctuations were a contributing factor to the apparent absence of CP. Several days later I was on a large boat going down the Amazon River on a six day trip to the coastal town of Belém.

Eventually I made it to the infamous city of Rio de Janeiro which was buzzing with the energy of the New Year's festival just days away. During my time there I visited the Jardim Botânico where displays of *Nepenthes* and other CP could be found. Even



U. reniformis giant leaf, from Caminho do Mar area near São Paulo.



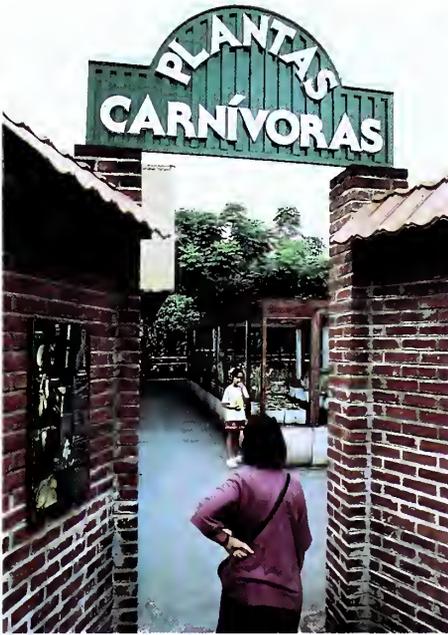
U. nana, Caminho do Mar.



U. subulata, Caminho do Mar.



U. nana, *subulata* and *tricolor* together in bloom.



"PC" world at the Morumbi Playcenter in São Paulo.



U. pubescens and a similar similar flowered species.



U. longifolia flowers



At the Ono's farm, along with Fernando and I.



D. montana, *communis* and *intermedia* together.



D. capillaris ssp. *brasiliensis* at El Pinar Beach, Montevideo, Uruguay

D. communis could be found. Instead we retreated to the Ono's home to relax over food and drink while chatting and looking through their collection of Japanese PC books.

Later in the week Fernando introduced me to one of his friends, a Biologist named Mauricio, who worked and maintained a large PC display at the local São Paulo Botanical gardens. The gardens were closed for renovations so that afternoon we visited the local amusement park, the Morumbi Playcenter, to see Mauricio's collection displayed in the "Plantas Carnívoras Exposition".

Inside the screened enclosure was an impressive selection of species including *Genlisea*, *Nepenthes*, Brazilian sundews and terrestrial bladderworts. *U. pubescens*, *U. longifolia*, and other bladderworts were in full bloom. When people came by to see the display, Fernando would give explanations along with dramatic demonstrations on how these insidious plants caught food. People would jump back in horror as inevitably a hungry pitcher plant or a Venus' fly trap would seemingly bite the end off Fernando's finger.

Paraguay

After so much success with PC in Brasil I was ready to find more as I bussed inland for Paraguay and the famous Iguazú waterfalls. Even though I could find no PC at the falls, there were still many other potential areas that were not accessible because of collapsed walkways and eroded trails. I was still left impressed by one of the world's largest waterfalls.

The capital city of Asunción, the botanical gardens and surrounding countryside, were hot and in the middle of a drought. My only reprieve after a day of unsuccessful plant hunting in forty (°C ed.) degree weather was a cold german-style beer back in town.

Uruguay

Undaunted by not finding PC in Paraguay, I head to the coast for adventures in Uruguay and the beautiful beaches there. Montevideo and the now standard trip to the Botanical gardens revealed aquatic PC that the curators were not aware of. I pointed out the yellow-flowered bladderworts in their ponds in exchange for directions to beachside sand dune ponds where there were supposedly *D. rotundifolia* growing. My curiosity was piqued since I knew, first of all, that this species of sundew did not grow in South America. Secondly, sundews growing in sand within a hundred metres of the ocean seemed equally unlikely. The thought of relaxing on the beach after getting there was an equally appealing thought, so off I went on the local bus to "El Pinar".

I was shocked at my finds at the beach. Behind the sand dunes, along a roadside ditch in front of some cabins, I found five types of PC in a square metre. The two types of sundews appeared to be *D. capillaris* ssp. *brasiliensis* and *D. brevifolia*, the latter being obvious with its red wedge shaped leaves and glandular flower stalks. There were also three types of bladderworts at this location, one being a yellow flowered aquatic form that appeared the same as that at the Montevideo Botanical Gardens. It was, more than likely, one of the many polymorphic forms of *U. gibba*. The small terrestrial purple-flowered bladderwort at the beach was identified later as *U. tridentata*. The even smaller terrestrial narrow leaf-bladed bladderwort there, with only seed pods present, later proved to be a cleistogamous form of *U. subulata* upon flowering. I will never doubt anyone's claims of ocean-side CP again, especially after an experience like the one at El Pinar, Uruguay. (*To be continued.*)

Does *Pinguicula Bohemica* Exist?

By Miloslav Studnicka¹
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and
Slavomil Hejny
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The Czech butterwort, *P. bohemica* Kraj., an endemic species of lowland swamps in Bohemia (CSFR), has been known for about 65 years (Krajina 1927). It was considered to be a variety of *P. vulgaris* in the well-known Casper's monograph (1962, 1966). In consequence of this opinion, the name *P. bohemica* was included as a synonym of *P. vulgaris* in the Synopsis of Carnivorous Plants in CPN (Schlauer 1986). In the Czechoslovak "New Flora", however, the species is named and described without any doubts (Dostál 1989).

A thesis has been elaborated, to include biometrical, morphological, and cytological comparisons of *P. bohemica*'s population to that of *P. vulgaris*, growing in quite similar natural conditions (Studnicka 1989). Several biometric differences are statistically significant, according to the thesis. Nevertheless, the following qualitative properties are the best features for species determination.

The corolla of *P. bohemica* is whitish, but in the mouth of the corolla tube there is always a characteristic dark drawing (Fig.1). This violet spot never occurs in *P. vulgaris*, which has a white mouth in the corolla tube. That is why *P. bohemica* may also be easily

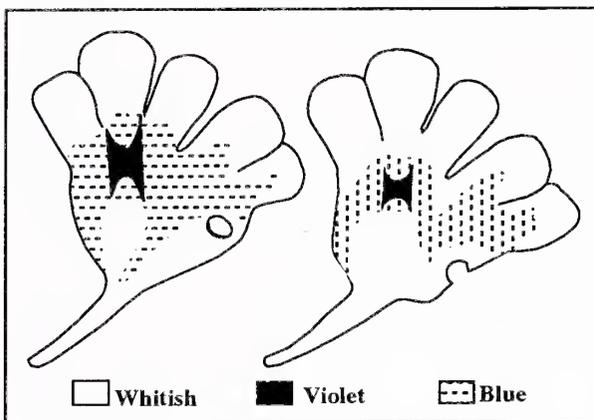


Figure 1—Inner coloration in the corolla of *P. bohemica*. Cut of 2 specimen, lower lips on the left side
evolutionarily modern *P. vulgaris* (Fig. 3).

As for ecology, *P. bohemica* can grow in the contemporary climate of Central Europe

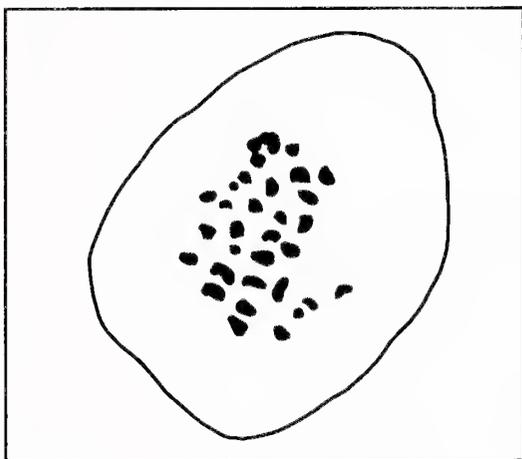


Figure 2—Chromosomes of *P. bohemica*.

moved from northern Europe (Fig. 3). There was certainly a long interval between habitations of both these species in Bohemia.

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distinguished from the well-known albinotic varieties of *P. vulgaris* (f. *albida* and f. *bicolor*).

Parallel and concave lobes of the corolla are also very characteristic of *P. bohemica*. The species *P. vulgaris*, with flat divergent lobes, is quite different (photographs 1&2).

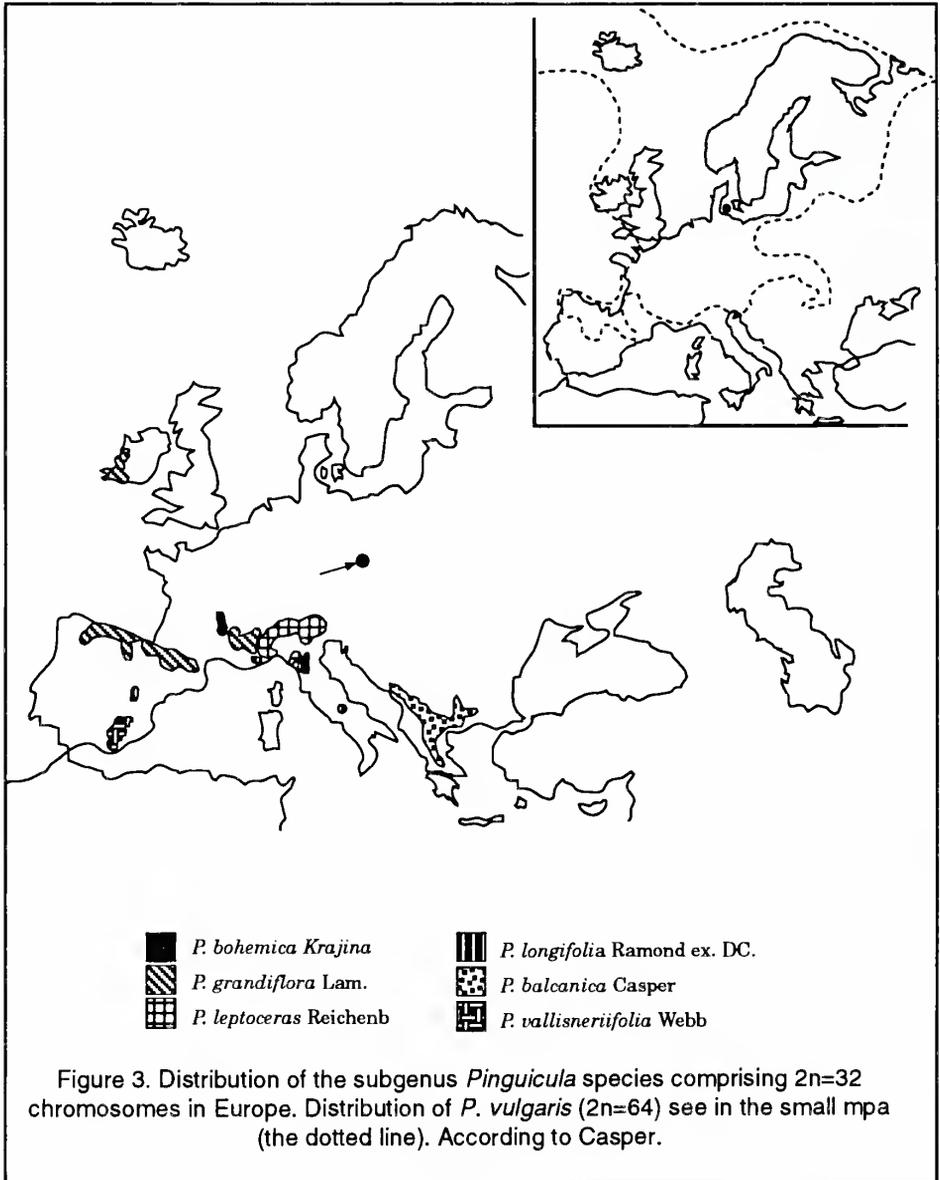
An important difference has been found in chromosome numbers: $2n=64$ in *P. vulgaris*, $2n=32$ in *P. bohemica* (photo 3, Fig. 2). The Czech butterwort is more related to further species with $2n=32$ than to the

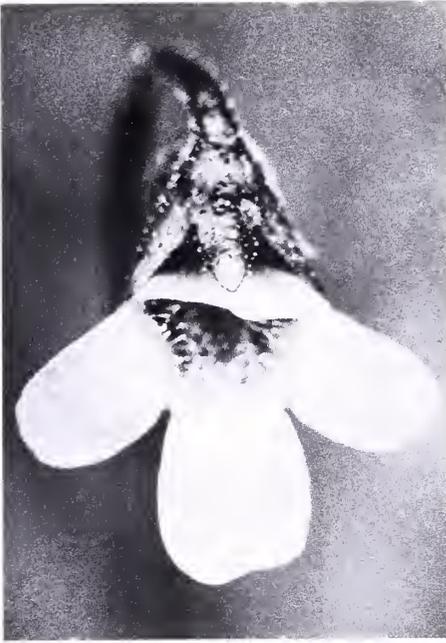
only in lowlands, while *P. vulgaris* grows both in lowlands and the mountains. *P. bohemica* grows in three micro-localities in a pure population where it does not mix together with *P. vulgaris*.

We can express a clear consequence then: the species *P. bohemica* is not a product of a wish, a dream, or a fantasy of Czech patriots. It is a lowland species, well distinguished morphologically, genetically, and ecologically. We can assume that the evolutionary predecessors of *P. bohemica* came to Bohemia from Southern Europe and occupied an area confined by the mountains (see Studnicka 1981, p. 40). On the contrary, *P. vulgaris*

Studnicka, M. (1989): Paper on the critically endangered species *Pinguicula bohemica*, with respect to its life-saving possibilities. msc./thesis, Czechoslov. Acad. Sci., Bot. Inst., 252 43 Pruhonice, CSFR; 185 p., Czech.

¹Miloslav Studnicka (Kominicka 600, 460 01, Liberec 4, Czechoslovakia) is well known in these pages for his articles on *Pinguicula bohemica*, among other things. He has written in the past that the habitats for this species, and therefore the species, are quite endangered. Now his country is engaged in a habitat recovery program and Miloslav is propagating hundreds of *P. bohemica* by means of culture to replace back into original locations, historically as well as more recent. His laboratory is attempting to make the resulting plants as genetically diverse as possible to see if this will enhance survival.

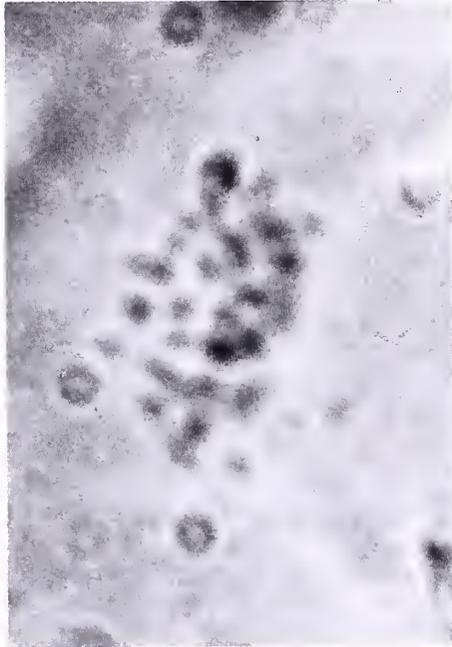




Flower of *P. vulgaris*.



Flowers of *P. bohemica*. See the concave and parallel lobes of the corolla.



Metaphase in a root meristem of *P. bohemica*.

Structural and Developmental Diversity of *Utricularia* Traps

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This paper presents a collection of scanning electron micrographs showing architecture, function, and development of the traps of various species not or only partially described by Lloyd (1931, 1932, 1942), Thurston & Seabury (1975), Meyers (1982), Fineran (1985), Sasago & Sibaoka (1985), Juniper et al.(1989), Taylor (1989), and Richter (1989,1990).

Trap features common to most *Utricularia* species

There are about 214 bladderwort species (Taylor 1989). All of them produce traps (bladders) to catch small animals, algae, or soil particles in the water or mud.

The traps are stalked, lens-shaped bladders. Their wall is about two cell layers thick. The inner lumen is sealed by a valve-like elastic door (D in Fig. 1) that is in tight contact with a multicellular threshold (T) preserving the shape of the opening. The primordial trap shows a slit as the first sign of bladder formation (Figs. 9, 12). The upper lip becomes the trap door while the lower lip forms the massive threshold.

The side walls of the trap are flexible. In the set phase the side walls are bowing inwards due to a negative hydrostatic pressure inside (Fig.10). Opening and closing of the door during firing may happen extremely rapidly, within 30 milliseconds or so (Sydenham & Findlay 1973, Fineran 1985). After firing, the bladder is filled, and the side walls are convex (Fig.11). Resetting (by pumping out up to 40% of the water inside) requires 15-30 minutes (Sydenham & Findlay 1975, Sasago & Sibaoka 1985, and own observations).

There are various types of trichomes (hairs) along the internal and external trap surface (Thurston & Seabury 1975, Fineran 1985, Juniper et al.1989):

- Quadrid and bifid trichomes (Fig. 1) act as internal glands; they mainly absorb water during the resetting phase. Afterwards, they may secrete digestive enzymes and absorb digested products of the victims (Fineran 1985, Juniper et al.1989). Quadrid trichomes are evenly scattered along the inner side of the trap, whereas bifid trichomes are restricted to the inner face (underside) of the threshold. The shape of the quadrid trichomes can be used to distinguish some *Utricularia* species (see Taylor 1989).

- Densely packed glandular cells (called pavement epithelium) are found on the outer face of the threshold on which the door lies when the trap is closed (Fig. 1:pe). The pavement epithelium prevents leakage of water into the trap when it is set (Juniper et al.1989). Sydenham & Findlay (1975) and Sasago & Sibaoka (1985) observed in traps resetting under paraffin oil that water is extruded at the door and not elsewhere. From this observation they concluded that pavement epithelium is functioning as water extrusion area (see also Juniper et al.1989:68,124).

- Club-shaped or long-stalked mucilaginous glands are located around the interior of the trap entrance (Figs.15,17). These glands produce a starch-containing mucilage (Thurston & Seabury 1975). This mucilage seals the door after firing and may also attract prey (Fineran 1985, Juniper et al.1989).

- The trap entrance is often ornamented with about four nonglandular hairs (Figs.1,8,15). They are called trigger hairs because they are believed to function in tripping the trap door (Sasago & Sibaoka 1985, Juniper et al.1989).

- Many species are provided with antennae (A) and bristle hairs (B) guarding the

trap entrance (Figs. 7, 14, 17). Sometimes, mere touching of these antennae triggers firing. These appendages may serve to direct potential prey to the door (Juniper et al.1989:66).

- The external trap surface (apart from the entrance area) may or may not be covered with globular glands (Figs. 1, 6, 13, 19). These external glands may help in water extrusion from the trap although this commonly held opinion was questioned by Sasago & Sibaoka (1985) (see also Juniper et al.1989:70).

Trap features distinguishing *Utricularia* species

The range of trap variation was already intensively studied by Lloyd (1931,1932). The shape and size of the traps, as well as the position of the mouth, appendages and door, differ considerably between species and are often used for species identification (Juniper et al.1989, Taylor 1989). Regarding the genus *Utricularia* in general, the traps range in size from 0.2 to 6 (or even up to 10) mm.

Trap Position: The traps may arise from the stolons (e.g., *U. humboldtii*, Fig.2). Or they may arise from the leaves (e.g., *U. foliosa*, Fig.12).

Degree of trap coiling: Trap development may happen without coiling at all, e.g., in *U. livida* (terrestrial, Figs. 9-11), and *U. foliosa* (aquatic, Figs.12-14), both species with terminal position of the mouth. In *U. alpina* (which is terrestrial or epiphytic) the trap primordium starts to coil soon after its formation from the stolon surface (Figs. 3-5, see also Brugger & Rutishauser 1989). The mouth of the maturing trap is basal, i.e., situated next to the bladder stalk (Figs. 6-7). Similarly, various aquatic and terrestrial species show obvious trap coiling during development (*U. gibba*, *U. tricolor*, *U. dichotoma*, Figs. 16-21).

Shape and number of appendages around the trap entrance: Some epiphytic species like *U. alpina* possess two unbranched antennae covering the lateral areas of the trap mouth (Fig. 7). *Utricularia humboldtii* may or may not show two antennae on the traps. Especially mature large traps are devoid of antennae at all (Fig. 8). A pair of branched antennae is observable on the traps of *U. foliosa*. The antennae of this species are entire during early trap development (Figs. 12-13). Later, each primordial antenna divides up into three long bristle hairs (Figs. 14-15). In *U. gibba* (including *U. biflora*) there are a few bristle hairs in addition to the two prominent branched antennae (Fig. 17, see also Thurston & Seabury 1975). The trap entrances of *U. tricolor* and *U. dichotoma* are covered by wing- or sail-like appendages, with or without marginal teeth (Figs. 19, 21). In *U. dichotoma* there is in addition a long spine forming a beak (Fig. 21). Several radial rows of prominent glandular hairs around the trap entrance are typical for *U. livida* (Figs. 10-11) and other closely related terrestrial species like *U. sandersonii* and *U. bisquamata* (see Taylor 1989, Brugger & Rutishauser 1989). In other species as *U. humboldtii* positionally equivalent glandular hairs around the trap entrance are quite inconspicuous (Fig. 8).

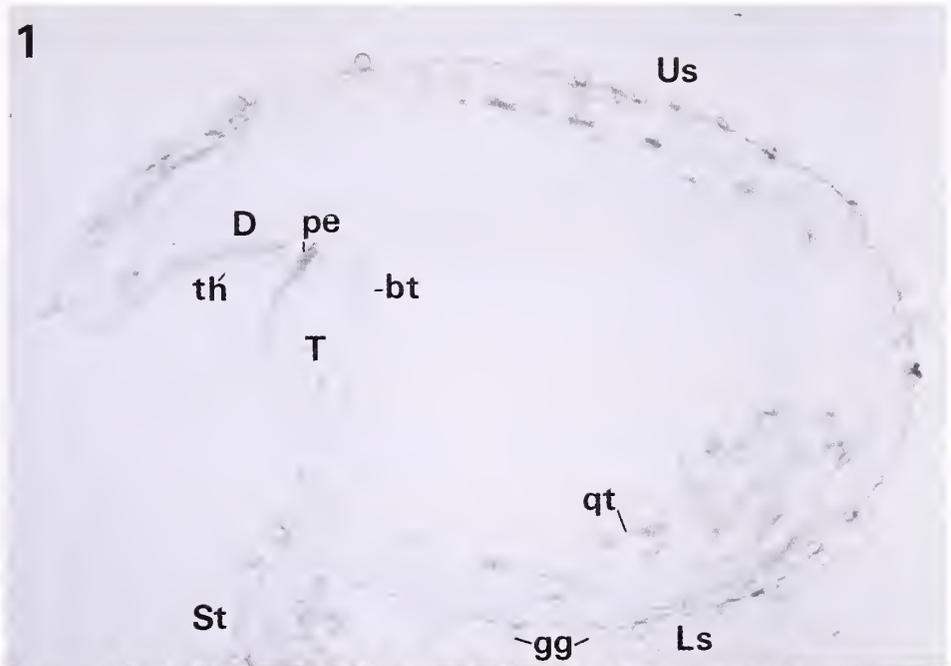
Besides the trap features mentioned above there are other vegetative characters useful to distinguishing the sections and species of *Utricularia* (see Brugger & Rutishauser 1989, Juniper et al.1989, Rutishauser & Sattler 1989, Taylor 1989).

Concluding remarks

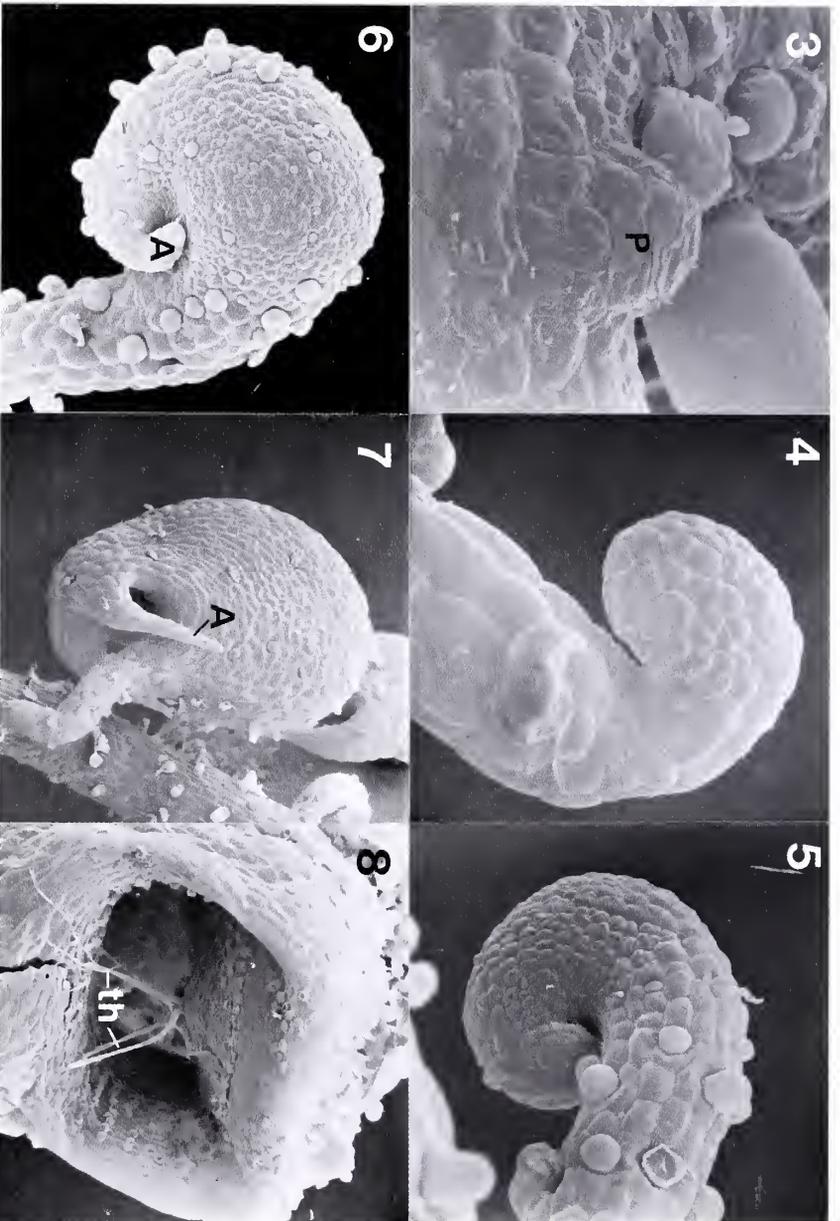
Since Charles Darwin, several botanists and other plant lovers were intrigued by the unique trap mechanism and bladder morphology in the genus *Utricularia*. However, the mechanism causing the traps to fire is not yet fully understood (Fineran 1985, Juniper et al.1989). We can only speculate about the functional significance (adaptive value) of certain trap features, e.g., the position of the trap entrance and the varying appendages (antennae, papillate hairs, wings) protecting the entrance. Terrestrial and epiphytic species with their traps in mud or wet soil normally show less prominent antennae and bristles than aquatic (i.e., submerged) species. Some of the trap features, however, may not even have an adaptive value at all.

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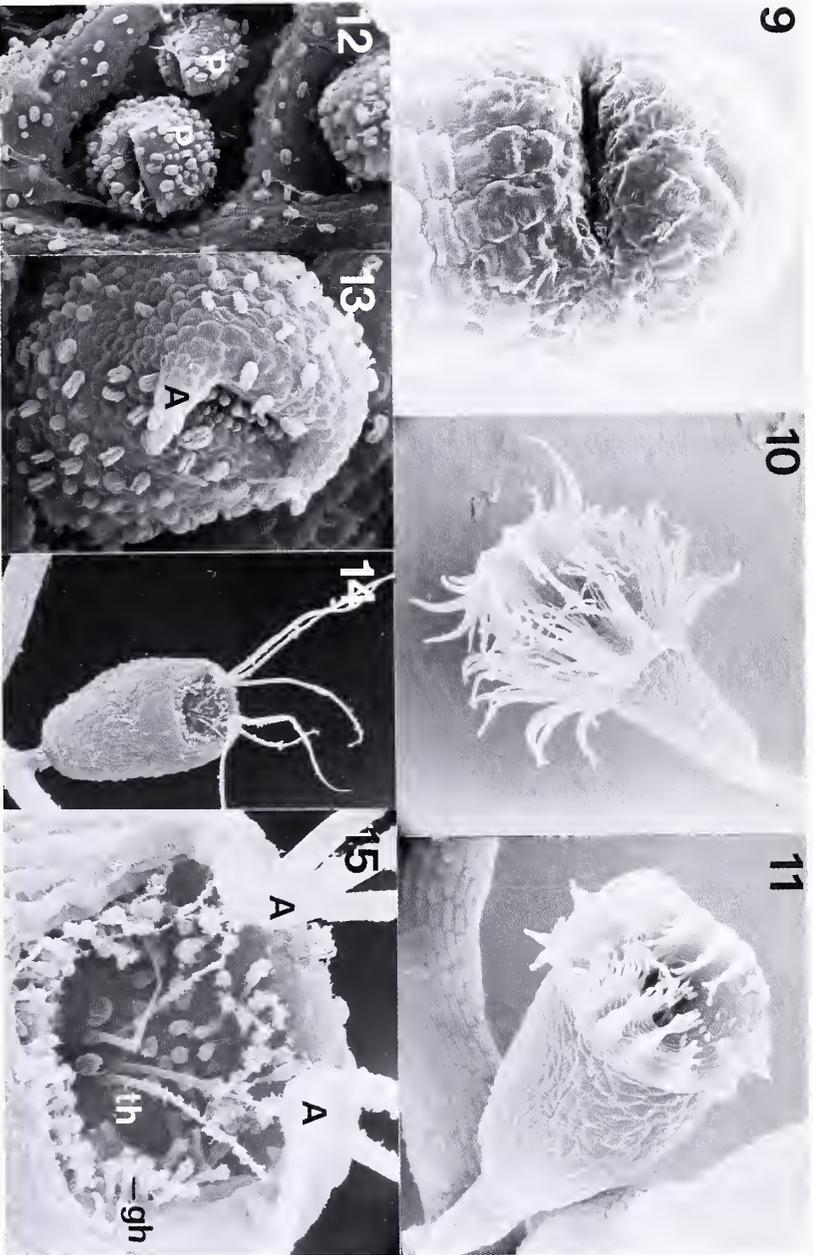
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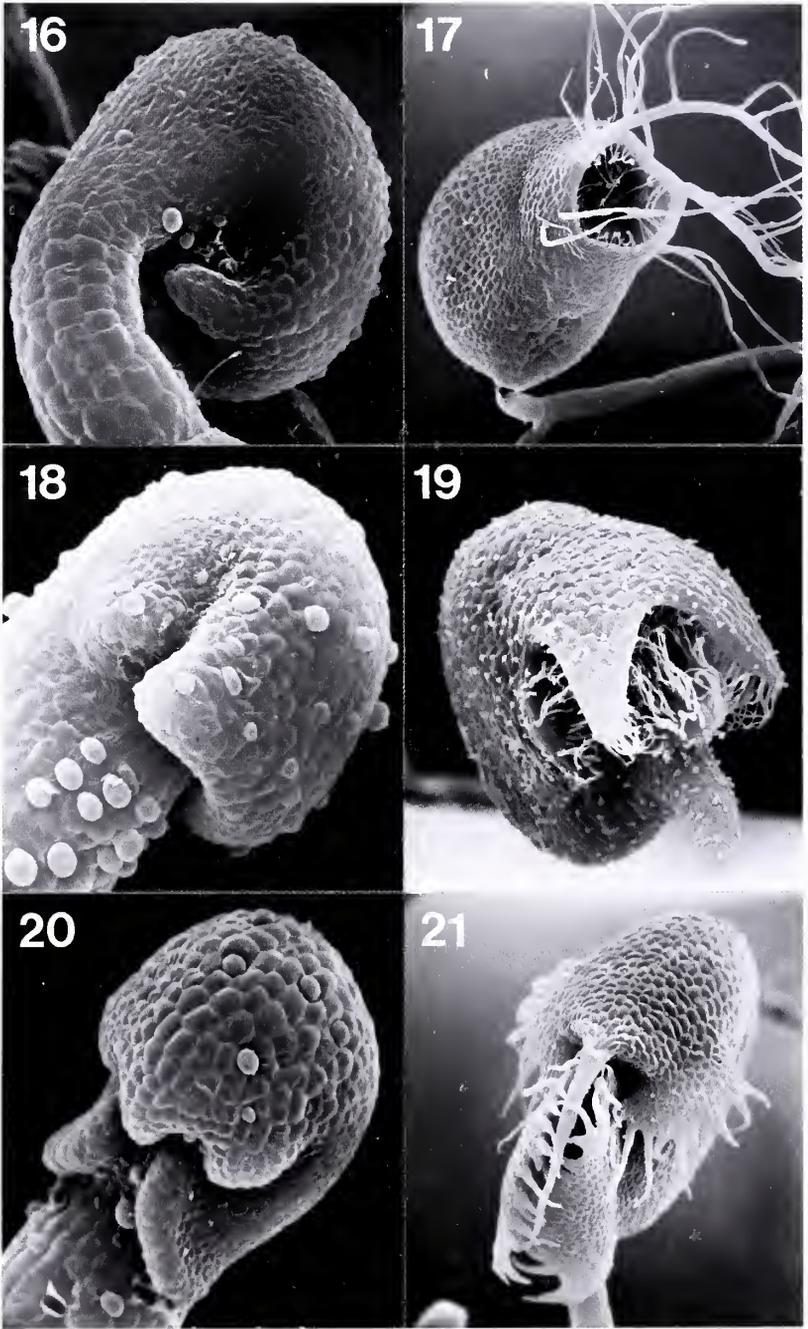
Figs. 1-2. *Utricularia humboldtii* (epiphytic, from Venezuela, cultivated by L. Bütschi, Sundew Farm, Bern). - 1. Longisection of mature trap. Us = upper side, Ls = lower side, St = stalk, T = threshold with the pavement epithelium (pe) on the outer side and bifid trichomes (bt) on the inner side, D = valve-like door, qt = quadrifid trichomes, gg = globular glands. - 2. Dense network formed by thick stolons (S) and thin stolons (s), large and small traps. 60x / 1.8x



Figs. 3-8. *Utricularia alpina* (terrestrial or epiphytic, cultivated at Zurich Botanical Garden). Trap development.—3. Trap primordium (P) arising from a stolon.—4-5. Two consecutive stages of trap development. Notice coiling of the primordial trap.—6. Young trap with antenna initials (A).—7. Mature trap with two antennae (A).—8. *Utricularia humboldtii*. Entrance area of 4 mm big trap, th = trigger hairs. 1260x / 690x / 330x / 170x / 65x



Figs. 9-15. *Utricularia livida* (terrestrial, cultivated at Zürich Botanical Garden).—9. Trap primordium with initial stage of mouth formation.—10-11. Mature traps.—12-15. *Utricularia foliosa* (submerged aquatic, from S. Florida. R. Rütishauser 9/1988—12. Detail of young pinnate leaf, with trap primordia (P).—13. Young trap, with antenna initials (A).—14. Mature trap with two trifid antennae.—15. Entrance of trap shown in fig. 14, A = antennae, interior of entrance with glandular hairs (gh) and trigger hairs (th). 850x / 55x / 75x / 130x / 265x / 48x / 240x



Figs. 16-21. Young and mature traps, respectively, of three additional species.—16-17. *Utricularia gibba* (submerged aquatic, fixed specimen from North Carolina: R. Rußhauser 10/1988).—18-19. *Utricularia tricolor* (terrestrial, cultivated by L. Buitschi, Sundew Farm, Bern).—20-21. *Utricularia dichotoma* (terrestrial, cultivated at Zürich Botanical Garden). 375x / 50x / 320x / 45x / 260x / 55x

Observed Variation in *Drosera Auriculata* and *Drosera Peltata*

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This article is based on my own observations of plants of *Drosera auriculata* and *D. peltata* in the wild and in cultivation; in all cases the geographical origin of the plant is known and taken into account. The majority of the variation relates to plant colour and stature. I observed no differences in flower structure of both species and I believe that I am simply documenting (some) of the variation within both wide-ranging species.

Variation in *Drosera auriculata*

The main variation in *D. auriculata* concerns the presence, or absence, of a basal rosette, the thickness, and to a lesser extent, height of stem and colour of the flowering parts.

At home, in Mulgoa, NSW, large colonies of this species occur. The majority of plants commence above-ground growth in March (a trend shared with most other tuberous *Drosera* species,); however, some plants can usually be found in active growth in December if appreciable summer rain has fallen. These summer growers often flower in March when they are producing a new stem in-phase with the rest of the plants.

This species typically occurs as colonies of between ten to at least one thousand plants. The dominant morphology is that of a weak, slender, trailing/scrambling stem to 50 cm tall. The plants either produce a sparse basal rosette of 3-10 leaves followed by a stem, or boycott the rosette stage and immediately produce a stem where the lower leaves are reduced to stipules. At first self-supporting, the stem begins to trail on the ground or over adjacent vegetation when it reaches 10-15 cm in height. In some instances, where the plant has produced a number of daughter tubers, the stems grow in very close proximity and are able to support each other by intermeshing leaves and can remain upright to heights of up to 40 cm before they submit to gravity.

Buds are produced from June and flowering commences later that month, continuing into October, or even November, dependent upon when the soil begins to dry out. Petal colour is usually white although a few light-pink petalled forms occur. The ovary is green, styles and filaments are white and the pollen is cream to pale yellow. The flowers are open on sunny days from mid-morning to mid-afternoon. Mass-flowering seldom occurs with this form and is generally a very staggered affair with rarely more than a dozen flowers open at any one time, even in the largest colony.

Another form of this species grows at Mulgoa which has a very well-developed basal rosette and produces stem growth from late June/early July, at the same time as local *D. peltata* plants. The stem reaches between 8 and 30 cm tall, with plants over 15 cm tall requiring support from surrounding herbage. The plants flower from October until the soil dries out, the petals are pink in bud, open white and dark pink when withered. This form often occurs in small groups amongst the other form of *D. auriculata* at Mulgoa.

An attractive rosette-forming, mid-pink petalled form occurs in the upper Blue Mountains, and has also been found near Kandos to the north-west. Above ground growth appears in March, culminating in a well developed (8 to 15 leaf) basal rosette

by June when stem growth commences. The stem is thick (to 2 mm diameter) and self-supporting, reaching 8-50 cm in height. In cultivated plants, flower buds are formed from August and are open from September to October. In nature (at higher elevations) buds are produced later and flowers are open from late October to early December. The petals are a substantial shade of pink and are slightly larger (1 cm diameter) than those of the white-petalled forms (8 to 9 mm diameter). The ovary is green, the style and filaments are white and the pollen is cream/pale lemon in colour.

I have observed pink-petalled plants at Wilson's Promontory, Victoria, and in Tasmania. The Victorian plants were observed beside the path to Mt. Oberon on Dec. 30, 1986. The plants grew to 30 cm tall and were in stages of growth between flowering and full dormancy. The basal rosettes had withered at the time so I am not sure if this form is exactly the same as the Blue Mountains form. A very similar form is nicely illustrated in Marcel Lecoufle's book, on pages 74 and 75, labelled as *D. peltata*.

In 1991, I observed similar plants in western Tasmania and at Mt. Nelson, Hobart. The western Tasmanian plants grew in well-drained soil and flowered from early February to late March. In sheltered locations these stems persist into mid-winter and have new rosettes forming in June. In open situations the plants produced a basal rosette to 2 cm diameter, but where the surrounding herbage was too dense, the plants immediately produced a stem and the leaves on the lower 10 cm were reduced to stipules. Plants grow to 40 cm tall, often producing two or three branches which terminate in an inflorescence.

Colourwise, the form develops a tomato-red main stem, pedicel, sepals and lamina. The petioles of the cauline leaves are green with a red end at the base of the lamina. The tubers are found to be white. A similar form grows at Mt. Nelson in a number of locations in dry Eucalypt forest. A sparse basal rosette emerges in March, pink-petalled flowers are produced from September into late November when the soil begins to dry out. The tubers have a red surface.

An unusual form occurs at Richmond, N.S.W., growing with *D. burmanni*. I have observed this form only twice. It grows in sandy soil, in light shade and does not form a basal rosette and grows to 10 to 15 cm tall. Other differences include the all-green colour of the petiole and the flower colour. The petals, filaments, stigma and style segments are white, the pollen is yellow and the ovary and style are orange/brown. Thus the flower looks very much like that of *D. peltata* "Western Australian" form as shown on page 91 of Allen Lowrie's first volume (1987).

Variation in *Drosera peltata*

This species appears to have better defined variations than *D. auriculata* and lacks intermediate forms; it also adheres more rigidly to a growth cycle of March emergence and spring dormancy following seed-set or the onset of dry weather (with the notable exception of *D. peltata* ssp. *gracilis* in the wild). In general, this species is found in heavier soils than *D. auriculata* and rarely do both species occur together.

Green rosette/pink-petalled form

This form grows at my home and has been observed at Castlereagh (west of Sydney) and near Kandos, N.S.W. It forms a substantial rosette with up to 30 golden-green leaves between March and June/July when stem growth commences. The stem grows to between 10 and 50 cm tall and is self-supporting for all but the tallest of plants. As the stem ages, it changes colour from golden green to red, from the base up. Colonies of this form obtain a distinctive red colour due to the reddening of the stems; the basal rosette, however, remains golden green. Plants collected by a friend at Orange, N.S.W., retain the golden-green colour over the entire plant, save for the retentive glands. The latter form appear to be closest to those plants described by Bruce Pierson (1990).

Red-rosette/white-petalled form

I have observed this form growing in the upper Blue mountains and also in very wet soil near home (growing with *D. spathulata* and *U. lateriflora*). It is a less robust form than that described above and produces a self-supporting stem to 15-20 cm tall. The sparse basal rosette is fully red in colour, even in shade-grown plants. The rosette grows from March with stem growth commencing in June. As the stem grows it changes in colour from bronze to dark green, as do the petioles, and the basal rosette withers away. The cauline leaves remain green with red retentive glands. The olive-green coloured flower buds emerge from August and the flowers are open from September to early November. At higher altitudes flowers are open from October to early December. Colourwise, the petals, filaments and styles are white, the pollen is cream/pale lemon and the ovary is green.

***D. peltata* "Western Australian form"**

This form is well described in "Carnivorous Plants of Australia-Vol One" by Allen Lowrie (1987). It differs from the two forms described above. The salient differences are the uniform bronze-red colour of the entire plant, and the white petals, filaments, stigmas and style segments, bronze ovary and style, and orange pollen.

D. peltata* ? *ssp. gracilis

This diminutive form was encountered in western Tasmania and is reported from other cold temperate locations in Australia (Erickson, 1978). Unlike the other *D. peltata* forms described above, it follows a pattern of summer growth and winter dormancy in the wild (however in cultivation in mild temperate climates, it changes over to summer dormancy with Autumn emergence).

In the wild, this form has a well-developed basal rosette to 2 cm diameter. The single slender stem grows to 25 cm tall and supports a very few cauline leaves. It is surmounted by an inflorescence, the length of which often exceeds the length of the leaf-bearing stem. The white-petalled flowers were observed from late January to late March, most of which set seed. Overall, the plants are a tomato red in colour.

Plants of this form were found in permanently water-logged peaty soil. The red tuber was found between 2 and 5 cm below the soil surface. I could find no evidence for the presence of a stoloniferous root system, a diagnostic feature of *D. peltata ssp. gracilis* (A. Lowrie, 1991, pers. comm.). However, the slender, diminutive nature, summer growth pattern with autumn flowering of the plants I observed are all consistent with this subspecies.

In summary, both *D. peltata* and *D. auriculata* resemble each other and can be difficult to tell apart when flowering parts are absent. The presence or absence of a basal rosette is by itself an insufficient means of distinguishing between species, but it can be useful in conjunction with observations of other features. From my observations, both species may be told apart by the colour of the petiole of the cauline leaves. In most forms of *D. auriculata*, the petiole is green with 2 or 3 mm of red or pale green colour adjacent to the base of the lamina. Whereas in *D. peltata* there is more variability. In the "Green-rosette/pink-petalled form" the cauline petioles are all golden-green. However, in the "red-rosette/white-petal form" the petiole colour is very similar colourwise to most *D. auriculata* forms, but the fully red rosette is not shared with *D. auriculata*. The uniform colour and totally separate range of *D. peltata* "Western Australian form" makes it easily recognizable.

The habitat of the species and timing of growth can be a useful guide in determining their identity. *Drosera auriculata* is a much more opportunistic grower than *D. peltata*, and generally prefers better drained soils. Both species rarely grow

together. *Drosera auriculata* has been found in growth and flower at all times throughout the year, dependent upon location. *Drosera peltata* follows a more rigid annual growth pattern; but even so, the various forms ensure that this species flowers through most of the year within its range. From my observations to date, the flower structure of all forms of both species do not differ. Only the colour of the flower components differ. Thus we are simply dealing with some of the variation in two distinct species.

Hybridization has been suggested as a possible explanation for the observed variation of both species (Pierson, 1990; R. Tilbrooke, 1990, pers. comm.). I have yet to find support for this hypothesis however, and further work is required in this area.

The purpose of this article was merely to give an account of some of the variation encountered in a small part of the range of both species. It would be useful if this work could be carried out through the rest of their range.

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Acknowledgments

I wish to thank Bruce Slamon for pointing out the identity of the plants in the photos of Marcel Lecoufle's book and also thank Dr. Donald Schnell for his advice in writing this article.

Another Method for Growing *Darlingtonia*

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After talking to several people, all growers of the "cobra lily", I noticed that for some people it is really easy, "Just set it in a tray of water and treat it like a *Sarracenia*" and for others like me, it isn't. It's daily waterings, icing, finding that "just right" spot, and then losing it when I go away for any length of time occurred too often. Or at least it used to be.

I lost two plants in a freeze last winter and started to ask myself if perhaps I should give up on this plant. Then , I found a couple of really nice specimens that were irresistible and decided that I was not going to lose any more of these plants. The following method was worked out very early last year and tested throughout the summer, and the plants are alive now and growing.

To start with, I use an aquarium (dimensions 20" x 20" x 12") with an under-gravel filter system installed. Three air lines are placed so that one is in the middle, between the filter plates, and the other two that drive the filter system are in the corners. I use a Whisper 500 air pump to supply the air, but any large air pump will do.

Over the gravel layer, I add a two inch layer of coarsely shredded live sphagnum moss. A second layer of unshredded live sphagnum is added to fill the aquarium to about the two-thirds level. It is in this moss bed that the plants are placed with no attempt to remove any compost clinging to the roots. Next, water is added until it is about one inch below the top of the moss. An aquarium thermometer is also added,

being pushed as deep into the moss as possible. After adding the water, it is time to turn on the air pump. The length of the plastic circulation tubes should be adjusted to allow the water to bubble over the tops of them into the surface moss.

I have this set up on the north-east corner of the house where it receives only morning and late afternoon sun.

The reason for doing all this is to keep the temperature of the roots low while providing an adequate amount of light for the plant to thrive. The plant grows best with its roots in circulating water of not more than 65°F. for any prolonged period of time. The combination of location and circulation achieves this goal, and the addition of filtration may benefit the plant by keeping bacterial build-up low. The location assures maximum light with a minimum build-up of heat in the water. Oxygen is also added to the water, particularly via the middle air line, possibly helping to counteract the noxious effects of bacterial growth.

I check the thermometer regularly and when the outside temperature gets above 80°F., I add ice which in my case was only needed for about two weeks during the hottest part of summer. That occurred when temperatures were in the mid-90s. I occasionally drain and replace the water in the summer, and add more water as needed. The plants are growing vigorously, producing pitchers to 16 inches although the average is 10 inches. Stolon growth is rapid and profuse, and there are flowers for the first time since I started growing *Darlingtonia*. It makes up for losing so many plants in the past.

Book Review

Rondeau, J. Hawkeye. *Carnivorous Plants of California*. 1991. 37
Sunnyslope Ave., San Jose, CA 95127, (408) 929-6529. pp. 50, \$15.95 +
postage.

The prime purpose of this book, published by the author, is to put together in one place all the historic literature and the author's own field observations on California's CP populations.

Each chapter is devoted to a plant genus after the introductory chapter that takes in consideration the weather, geology and concepts of what constitutes the trapping mechanism of each plant type. In California's Floristic Province, as the author puts it, there are only 9 native species: five bladderworts, two sundews, one butterwort, and one pitcher plant.

All the chapters have the same organizational headings for each genus such as botanical and common names, status as to abundance, a general description, species description, prey and trap function and flowering period. Additional headings such as trapping period and survival strategy, range and habitat and finally associated species rounds out the chapters.

Interspersed throughout the book are three pages with color photos of *Drosera*, *Pinguicula* and *Utricularia* and two pages with maps and a couple of pages with diagrams of the leaf or flower of a CP. The distribution maps are broad enough of both California and Oregon to reveal little clue to where the plants are located exactly and rightfully so. Instead, the author gives a listing of where the plants are on public display and where they can be purchased from local growers.

Finally, a long bibliographic reference list ends this book for those who would like to pursue further information about these fascinating plants.

I found this book to be a fine addition to anyone's collection of CP books since it describes, explains and points out flaws in the information which we seek about these plants.

Literature Review

Bulletin of the American Rock Garden Society. 50(1), Winter, 1992

We are reviewing pertinent articles from this issue of a bulletin under one title for convenience and because of the relatedness of the articles.

The cover features a full color painting of a *Sarracenia* hybrid by Rob Proctor of Denver, Colorado, and the rendition is of excellent quality.

The first article related to our interests is by CPN co-editor emeritus Larry Mellichamp and entitled "Hybrid Pitcher Plants" (pp. 3-10). The author has a brief introduction on growing bog plants in general, and then comments on the nature of sarracenias, species, history, etc. The bulk of the article is an interesting summary of his work in producing horticultural hybrids of sarracenias, or selecting them from field plants in some cases. In this process of production, one makes a cross between two selected plants for prime characters desired, germinates all the resulting seed (ideally), and the carefully selects which few of the progeny are worthy of vegetative propagation as horticultural hybrids. The remaining discarded plants are sold at annual plant sales at the UNCC Botanical Gardens in Charlotte, NC. Larry mentions that he and others are attempting all the possible sarracenia crosses, and lists the results of interest thus far including several published horticultural hybrids. He mentions difficulty retaining sterility in attempted tissue culture, so at this point must rely on the slow natural growth and division of plants which results in few progeny at this time.

The next article by Roberta Case is entitled "A Sphagnum Bog Garden" (pp. 11-12) in which the author mentions a few salient features of sphagnum bogs in general and then describes her construction of one adjacent to a pond on her property. A unique feature is her bypassing the need for purified or native hard water (which would destroy the live sphagnum) by siphoning aged water from the adjacent pond in a permanent siphon setup which is clever. Tap or hard water is used to replenish the pond as needed, but dilution and chemical changes of aging render the water ultimately safe for sphagnum.

The third article of interest is by Fred Case and entitled "Bog Gardens and Bog Plants" (pp. 45-46). This is actually the first of a two part installment and the second promises more specifics. The first part here gives main principles including soils, water, use of water courses or artificial waterfalls, light, etc.

The issue also has numerous well printed color photos of sarracenias in pots, bogs, gardens, etc. There are some labeling problems which were hand corrected by the individual supplying my copy, but these are not many at all. There are several other articles on water gardens, waterfall construction, etc. ARGS may be of interest to many of our readers since such plants and natural areas studied by members of ARGS are also companion to CP and their areas. For information about membership or individual issue purchase, write: Secretary, ARGS, PO Box 67, Millwood, NY 10546.

Chitty, F.D. 1990. Plantas insectívoras del estado Cojedes, Venezuela. Acta Botanica Venezuelica 16: 39-47. (In Spanish)

The State of Cojedes is located south of Caracas, far from the tepui country. One *Drosera*, *D. sessilifolia*, and five utricularias, *U. alpina*, *U. simulans*, *U. pusilla*, *U. foliosa* and *U. cucullata* are listed and a key given along with line drawings of each species. *U. foliosa* is by far the most common of the utricularias. (DES)

Cribb, A.B. 1987. An aquatic fungus from pitchers of *Nepenthes mirabilis*. Qd. Nat. 28:72-73.

While visiting nepenthes habitat along the Jardine River, the author noted a fungus in mycelial phase both free in pitcher fluid as well as attached to chitinous

remains of insects. A sketch shows a branching septate mycelium of rather non-specific appearance. Fruiting bodies and cultural characters were not discerned at time of printing. There apparently had been no previous record of an aquatic fungus from within a carnivorous pitcher cavity. (DES)

Folkerts, George W. 1989. Facultative rhizome dimorphism in *Sarracenia psittacina* Michx. (Sarraceniaceae): An adaptation to deepening substrate. *Phytomorphology* 39:285-289.

The author describes the situation where rapid accumulation of substrate (eg. growing sphagnum moss in which the plant is growing) seems to induce the development of a more elongate, rapidly growing branch of the usually nearly horizontal rhizome which is nearly vertical and tends to result in new leaves appearing above the substrate. This structure is termed a stolonoid, which also develops its own roots.

MacRoberts, M.H. and B.R. MacRoberts. 1991. The distribution of *Sarracenia* in Louisiana, with data on its abundance in the western part of the state. *Phytologia* 70:119-125.

_____. 1991. Floristics of three bogs in western Louisiana. *Phytologia* 70: 135-141.

These two papers by the same authors on the same general subject and in the same issue are reviewed together. They follow up on previous *S. alata* and Louisiana bog research reviewed in previous issues of CPN.

The first paper outlines the general ranges of *S. alata* and *S. psittacina* on a state map with parish outlines. *S. alata* is present in bogs along the western border and in a smaller area on the southeastern border of the state, the latter area containing the populations of *S. psittacina*. Older reports of other species are discounted, most after a review of herbarium sheets. Vouchers show specimens of *S. purpurea* from the last century, but the locations have not been refound. Most of the bogs are hillside seeps that are locally common but most are severely degraded, mostly by human activity.

The second paper describes three bogs, only one of which contains *S. alata*. Floristic and soil analyses are presented. The bogs are very close to one another. Floristic diversity is far less than savannas in the Carolinas. The pitcher plant bogs generally is somewhat more acid than the other two (pH 5.0 against 5.8 and 5.3) and has lower levels of calcium, potassium and phosphorus. All three bogs are somewhat less acidic than bogs described in previous papers. (DES)

Studnicka, Miloslav. 1991. Interesting succulent features in the *Pinguicula* species from the Mexican evolutionary centre. *Folia Geobotanica et Phytotaxonomica* 26: 459-462 + Pl. 10-13.

The author describes results of sections of Mexican succulent *Pinguicula* leaves. The presence of chlorophyll cell sheathing of vessels strongly indicates C4 photosynthesis. The upper (adaxial) leaf portion in cross-section contains mostly colorless water storage cells, while the lower (abaxial) contains additional photosynthetic cells. These findings apply to the succulent winter rosettes. (DES)

Zamudio, S. and J. Rzedowski. 1991. Dos especies nuevas de *Pinguicula* (Lentibulariaceae) del estado de Oaxaca, Mexico. *Acta Botánica Mexicana* 14: 23-32. (In Spanish)

That famous Mexican state of Oaxaca, location of so many *pinguiculas*, is now the location of still two more rather interesting species. The state must be quite large and have relatively inaccessible areas to continually yield additional species.

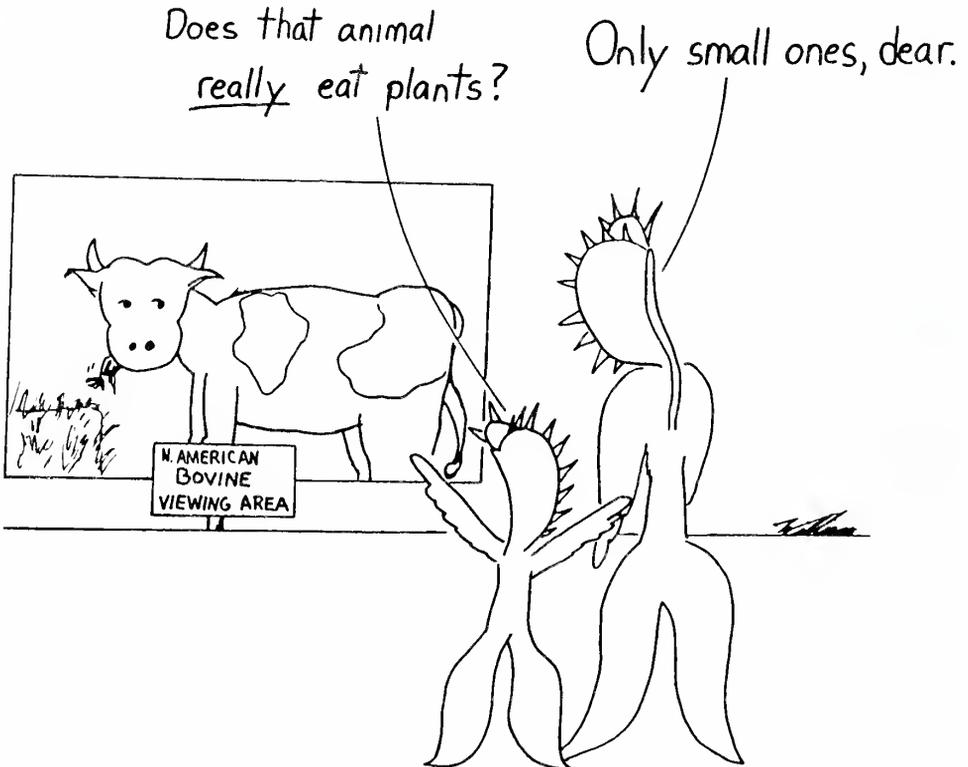
Both species, while somewhat similar in affinities to *P. moranensis*, are sufficiently different in the author's judgement to warrant their own generic section, *Longitubus*, this due to the longer funnelform floral tubes.

The first species, *P. hemiepiphytica*, is most commonly found in the usual temporarily wet sandy rock areas, or on mossy rock seeps, but has the interesting habit of being occasionally epiphytic on the bared roots and trunks of trees. There is a note appended to the paper in which the authors acknowledge that after going to press, a note by two Austrian botanists (Speta and Fuchs, *Phyton* 29: 93-103, 1989) had just come into print describing a similar plant in generally the same area as *P. laeana*, and that the plant is growing in the botanical garden in Linz. There may be a name precedent problem here if these are conspecific; however, Zamudio and Rzedowski state that the Austrian paper's plant description and location data are too vague to be sure at this point but that further study is warranted.

The second species, *P. utriculariodes* (the authors are to be congratulated for their descriptive epithets!) has the usual dimorphic leaf pattern expected of Oaxaca pinguiculas. The small winter leaves are thin and very small with a loose rosette pattern that superficially look very much like any of several tropical *Utricularia* leaves. The summer leaves are unique in that they have a spoon or scoop-shaped deep depression in their tips, looking somewhat like the intermediate leaves of *Cephalotus*. The article is accompanied by very good line drawings. (DES)

TIDBITS

BY
BILL STRAND



MANUSCRIPT SPECIFICATIONS

CPN is now being produced using a computer. We have entered the era of desk top publishing. Using Aldus Pagemaker 4.0 on the Macintosh has rendered hand paste ups obsolete and corrections quite simple. With this in mind, the editors are requesting that articles longer than one CPN page in length be submitted in one of the following formats.

1. 3.5 inch disk using Microsoft Word 4.0 or equivalent, using a Mac so that disk conversion would not be necessary and the desktop editor can import the file directly into Pagemaker. This will minimize typos—they would be your own. A laser printed hard copy should accompany the disk in case the disk is not readable and the document must be scanned. In any case, the hard copy will be used for editorial purposes. Use at least 12 point type (the type size in CPN is 9 point). Graphic materials (slides, prints, drawings) can be sent as before.

2. 3.5 inch disk from an IBM PC or clone. Include name of word processor (preferably Microsoft Word 4.0) and version. Hard copy should also accompany disk per above requirements.

3. Laser printed hard copy 10 point type or larger. Use a san serif font such as Geneva or Helvetica. This will be scanned and put into a Microsoft Word file using OmniPage 2.0 or higher.

4. Dot matrix 10 point or larger using a new ribbon. This will also have to be scanned. All dots should be clearly visible—we have had trouble with copies where the descenders are much lighter than the body of the letter—"y" scans out as a "v" for example. Please use regular white bond paper and print on one side only.

Documents that have to be scanned are subject to error. Usually a clear laser printed copy will be scanned with 100% accuracy, but special characters may be a problem. One of the co-editors (Leo or Joe) will have to do this and make sure the copy going to the desktop editor is clear of all scan errors. This of course will take more time. Options one and two are preferred and less subject to error.

At the present time, we are not set up to scan slides or prints, but hopefully soon we would be able to do this. All color still goes through a four part printing process. The time is coming where CPN may be available as a disk complete with color!

Send **all** completed manuscripts and any slides or artwork to our Editor-in Chief Joe Mazrimas; 329 Helen Way; Livermore CA 94550; USA.



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