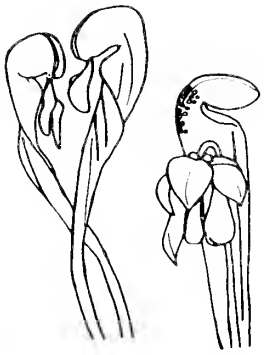
CARNIVOROUS PLANT NEWSLETTER

VOLUME 17, Number 4 DECEMBER 1988



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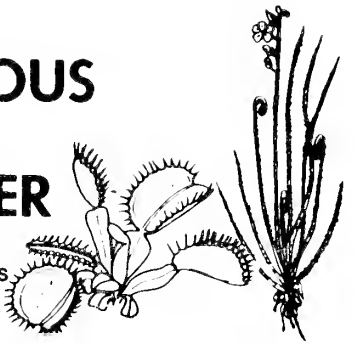
Official Journal of the International Carnivorous Plant Society



Volume 17, Number 4
December 1988

Front cover: *Sarracenia rubra* ssp. *alabamensis* in pitcher (front cover) and flower (rear cover). Photos in habitat by Donald Schnell. Please see article on page 104.

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 subscriptions 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.

Copy deadline for the June 1989 issue is March 11, 1989.

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SPECIAL ANNOUNCEMENT

Since subscriptions are by the calendar year-volume, you will find enclosed with this issue a renewal envelope. If you do not need to renew at this time or have already done so, then use this envelope for any communication with the Society. The Co-editors wish to take this opportunity to thank everyone for their support this past year. Also, we extend best wishes for a happy holiday season. Keep those papers coming.

Your co-editor, Leo Song, now can be reached via computer mail for those of you who have access to any network that interfaces with BITNET. My bitnet address is LEOSONG@ CALSTATE. The complete routing within the CALSTATE domain is CCS.CSUSCC. CALSTATE, but is not necessary to reach me.

NEWS & VIEWS

DAVID W. EICKHOFF (1224-409 Ala Kapuna St., Honolulu, HI 96819) has sent us some canceled stamps of the Republic of Palau, which is located in the Carolines in the Federated States of Micronesia. The $2.00 stamp features *Nepenthes mirabilis* in full color against a natural background and the plant's name is on the stamp. Nearby we have printed a black and white photo of a canceled stamp. The cancellation date is September, 1988, so unused stamps are likely available from the Palau postal service or stamp collectors' shops. A few years ago CPN featured an article on CP on stamps, and this particular one is new.

PAT KITE, 5318 Stirling Ct., Newark, CA 94560.

In the December issue, 1987, a book was reviewed on page 88 from England which I was informed was incorrect in its price. The Centre for Life Studies book on Carnivorous Plants informs me that the current price is 1.50 Pounds and not 57p. A copy sent by surface mail would cost 2 Pounds for book and postage, in English money only.

ROB MAHARAJH, (94 Ainslie Avenue, Hamilton, Ontario, Canada, L8S 2K2) writes:

Since placing an ad for trading and/or selling *Drosera villosa* in the June 1988 issue of CPN, I have been swamped with requests for this surprisingly large, very shy-flowering Brazilian *Drosera.* An even bigger surprise hit me upon realization that its attractively red-colored, strap-shaped, hairy leaves were not decorating the collections of ***any*** North American CP'erphile to my knowledge. That would explain the avalanche of orders! I obtained my original plant for 12 Swiss Francs (about $12 CDN) in a small plant shop in downtown Zurich while vacationing in Europe during the summer of '87. Consequently, I tried taking leaf cuttings and, after many a trial and failure, I finally struck 6 plantlets from 4 leaves. The method is as follows: cut off several leaves in the late fall - no more than 6 leaves from a large adult plant - keeping about at least 1 cm of petiole; then, place on the surface of

moist milled *sphagnum* making sure to tuck in the petiole into the moss but do not cover the leaf. The key to success, I believe, is to maintain a very high humidity environment and a constant temperature between 70-75° F 21-24° C. I accomplish this by placing the cuttings in a small plastic terrarium (12x22x16 cm width: length: height) having many small ventilation holes at its top. The container is then placed near an isothermally maintained, southern window where it gets about 3 hours of direct winter sunlight. Providing that the cuttings have not turned brown by about the 8th or 9th week, small buds will appear, sometimes 3 per leaf. Do not press down or clip the *sphagnum* moss which will naturally grow around and above the cuttings: this situation creates an ultrahumid microenvironment. After the plantlets develop their 4th or 5th leaf, they can be potted in pure milled *sphagnum* and placed in an area receiving a maximum of 4 hours direct sunlight. *Drosera villosa* makes an excellent fluorescent light subject. During the winter, my plants are grown indoors under a 2 tube, 48" long (one tube is cool-white; the other, "Grolux") assembly, complete with reflector, at a distance of 25 cm and set for a photoperiod of 14 hrs. The growing medium is moist but well-drained. Under these conditions, the plants develop a very desirable uniform bright blood-red coloration.

RICKY MAULDER, 145 Lone Kauri Rd., Kara Kare, Piha, Auckland, New Zealand.

Concerning the notes I wrote in the C.P.N., Vol. 14 (2), p. 32, I would like to state that I moved to a new area by the sea. Since I had no room in my glasshouse for some plants, I had to put many of my *Nepenthes* x *mastersiana* plants outside. I let one or two of them to dry out and the others planted in the ground were eaten by opossums or they grew very well during the cooler weather but summer proved too hot and burnt the leaves away. The *Nepenthes villosa* continued to grow well at the old house but I was too stupid, for some reason, to place this plant into the glasshouse. As a result of actually placing it on the edge of a heat board, it went downhill faster than a roller coaster and I managed to get it outside with only one leaf left. It continued to grow one leaf while the last leaf died. It survived this way for 4-6 months until it finally said goodbye to me. If I ever get a *N. villosa* or seed again, I will be sure it stays outside this time.

Soon, I will put more *Nepenthes* outside and these will be *N. tobaica* and *N. ventricosa* as I have plenty of these and they grow very fast all year. One *N. tobaica* seedling grew over 2 feet during the winter months and this is in a drafty, unheated glasshouse that is half-shaded by trees at a latitude of 37° south. The plant started out about 10 inches high in the autumn. Now, a year later, it is 8-10 feet long with several shoots 1-4 feet long. This is the fastest cold growing *Nepenthes* I have to date.

On the other hand, *N. reinwardtiana* not only looks different in its leaves, stem, pitcher, etc., but it is also a warm growing type. I have killed at least 20 plants from low and high elevations in trying to grow it cool. I have many other species of plants which will surprise you on whether they grow very cool or only warm but this will be reported another time.

I also am trying to pollinate flowers for seed of either species or hybrids but I have little luck. If anyone is interested in making *Nepenthes* hybrids or species seed, I would be interested in a pollen exchange system. This just might work with having opposite seasons down under.

I am planning to visit Sumatra in August, 1989, for 30-40 days. I may be spending most of the time moving from south to north looking for *Nepenthes* and plan to climb mountains in unexplored areas for new species or visit new areas looking for old species. If I have time after Sumatra, I may go to Sarawak, Kalimantan or Sulawesi but all this depends on what travel information I can obtain from readers. If anyone is interested, then contact me for further details especially if they are interested in going on such a trip. Also, I would be grateful to receive any information or an address where I can purchase maps of such areas like Kalimantan showing the mountain regions.

At this stage, I am planning to camp on mountains for one or more nights depending on accessability to the summits. At times it would be a rough trip! I don't intend to half-climb the domes and then return to a soft bed at nightfall. To explore the area fully, you may have to stay up the mountain for a full day or two.

JOE MAZRIMAS reports that the San Francisco Fair Flower Show had a great response from local CP growers. A variety of 85 plants were displayed this year—a substantial increase over last year! The exhibitors were: Mickey Urdea, Peter D'Amato, Mike Morris, Larry Logoteta, Charles Powell, Barbara Powell, Leonard Roth, Joe and Kathy Mazrimas, Kirk Henderson, Rex Walker and Geoffrey Wong. The best plant in the show was won by Geoffrey Wong which was a bonsai version of *Drosophyllum* and he also won the best Australian plant award for his huge *Cephalotus* specimen. The show was well attended and it was fun talking to all the growers and people with their questions about CP.

Best of show *Drosophyllum* bonsai. **G. Wong & best Australian plant.**
Photos by J.A. Mazrimas.

W. BARRY VanWINKLE, (3201 Overton Manor Dr., Birmingham, AL 35243) writes:

Now that everyone has seen Tom Gibson's color photo (CPN 17:84) of his glorious *N. rajah* pitcher, I'm sure there are many, like myself, "moved to ecstatic exclamation" (quote from above article) and clamoring "Where can I get such a wonderful plant?" I realize that these rarities are protected and on the CITES list so commercial sources are out for the most part. As a result, a colleague and I are setting up tissue culture systems for *Nepenthes.* While a slower process than cuttings, we should be able to raise more plants this way. I'd be most grateful to anyone if I could obtain *N. rajah* (or other scarcer *Nepenthes,* i.e. *lowii, edwardsiana, vietchii* etc) leaves (tendrils used in tissue culture) or seeds. Any source or help so we can spread some of these rare beauties to other collectors would be gratefully appreciated.

Should any of you be having trouble getting fresh bugs for your CPs maybe I can help. In my CP greenhouse I have a couple of *Stapelia,* also known as "carrion cacti" because of the "rotten meat" scent their gorgeous 8" diameter star-shaped flowers exude to attract flies. And attract them they do! Even in very cool weather. After their egg-laying frenzy, the flies seek to replenish themselves and the nectar glands of the strategically-placed *Nepenthes* beckon. End of fly and story!

SOME OBSERVATIONS OF A POPULATION OF *NEPENTHES MADAGASCARIENSIS* IN MADAGASCAR

By Gary James
Orange Coast College, 2701 Fairview Road, Costa Mesa, CA 92626

Madagascar, the fourth largest island in the world, is located about three hundred miles off the east coast of Africa. Geologists estimate that the island has been separated from other land masses for as long as one hundred million years. Because of this long isolation, many unique plants and animals have evolved on Madagascar.

Among the more familiar plants are the travelers palm, *Ravanala madagascariensis,* which is not really a palm but is more closely related to the banana and Heliconia groups of plants. The Madagascar periwinkle, *Vinca rosea,* is used in landscaping, and the pitcher plant, *Nepenthes madagascariensis* is of interest to people interested in insectivorous plants.

The southern part of the island is quite arid and the vegetation of this zone is nicely adapted to the climate. Each year the rainy season begins in December and ends in April with a long generally dry period from May to November. The temperature is mild throughout the year. The above mentioned plants are residents of the southern arid zone, at about 300 feet elevation. Near the town of Fort Dauphin, in southern Madagascar are many eroded hillsides with deep gullies and red sun-baked laterite soils.

The forests in this area have long ago been cleared by cattle herding tribesmen of the Mahafaly people who graze their herds on the sparse grasses which have replaced the forests. Burned every year during the dry season, the flush of new grass provides life sustaining food for the herds of Zebu cattle owned by the local people. The clearing of the trees and the burning of the grass exposes the clay soils to erosion. Gullies channel the hillsides and the exposed soil turns brick hard.

It is in this eroded landscape the *Nepenthes madagascariensis* makes its home. Scattered in dense clumps up to three feet across and twelve to eighteen inches high, the plants are found over a wide area growing among stands of *Ravanala madagascariensis.* The plants observed were healthy with many pitchers at the tips of the leaves. In August during our visit none were observed to be in flower. No doubt, with the advent of the rains in December, the plants will begin to flower. In August the soil was dry and little rain had fallen for many weeks. The pitchers were about one-quarter filled with fluid. A few were tipped out to reveal a large number of insects as well as much decayed material in the bottom of the pitcher.

The area we visited covered perhaps three to four acres, and there were hundreds of clumps of *Nepenthes* as well as many *Ravenala* scattered over the area. The *Nepenthes* were bright green in color and the clumps contrasted markedly with the dry clumps of grass. The hillside faced north so the plants were spared the direct sun and its attendant drying effects. The population was large and healthy. It is an area where tourists stop, adjacent to the main road, en route to a nearby lemur preserve.

Unfortunately, in a poor country like Madagascar there is little incentive to preserve areas such as this. The plants in this particular population are thriving but probably should be afforded some protection from trampling and collecting. There are no doubt many similar areas in the vicinity where these plants may be found. They seem to have adapted well to the harsh conditions on the hills where they live. Hopefully the population will continue to thrive on their southern Madagascar hillsides.

Nepenthes madagascariensis in Habitat

General habitat view.

Another clump of *N. madagascariensis.*

Eroded hillsides in Madagascar with *Ravenala* and *N. madagascariensis.* Photos by author.

Close-up view of clump of *N. madagascariensis.*

PROPOSED LISTING OF *SARRACENIA RUBRA* ssp. *ALABAMENSIS* AS AN ENDANGERED SPECIES UNDER THE U.S. ENDANGERED SPECIES ACT

by Donald Schnell
(Rt. 1, Box 145C, Pulaski, VA 24301)

On 13 May, 1988, I received a letter dated 27 April along with an outake from the Federal Register dated 21 April, 1988 from the US Fish and Wildlife Service of the Dept. of the Interior.

This material detailed the proposed listing for the pitcher plant *Sarracenia rubra* ssp. *alabamensis* under the Endangered Species Act. This official notification is intended to precede any responses from concerned individuals by either direct means or through local meetings. Unfortunately, all this must have been done in June, long before you read this. The process may be complete by then, in which case we will add a short notice to this issue. After the period for public response, the Congress will (on their own time schedule!) vote for final acceptance or not, and acceptance is most likely.

During the interim, the ESA rules state that no federal activity that endangers the proposed species can be undertaken without appropriate review. Following listing, all rules of the ESA apply, including shipment permits for material interstate. As a matter of ethics, we recommend that ICPS members treat the subspecies as though fully accepted during the interim period before final congressional vote.

The Federal Register goes into some detail concerning the history of the subspecies, a brief botanical description and location ecologic characteristics, and a rather complete bibliography. At one time, a total of 27 locations in the Elmore/Chilton/Autauga Counties area of central Alabama was documented but now only 11 are claimed to be known, three of these being of any significant size. As I have mentioned in a previous CPN article, I have managed to find several additional locations through various means. One of these has been timber harvested in the past three years after which the plants responded beautifully to increased light conditions in succeeding seasons. The location is rather high on a ridge but associated with a broad, slow seep slope at the edge and has over 100 genets with most of each of these having 25-50 ramets. The flowering was quite startling this past spring. Contrasting with the Federal Register statement of a typical habitat, the peat layer was no more than 3-5 cm on the surface immediately above solid or rarely sandy clay.

Contrary to the usual policy of listing plants for ESA acceptance, a site survey has not been done for this subspecies in order to protect location data, which certainly seems reasonable.

Since most of the locations are on private lands including those of a large timber company, little will probably be done to forestall fire prevention or encourage clearing and no other physical disturbance. As is the case so often, private intervention by an organization such as the Nature Conservancy to purchase or otherwise seek donation of good locations and then manage them appropriately may be the salvation of at least a few of the diminishing locations.

NOTE

Please see front and rear covers for photographs of *Sarracenia rubra* ssp. *alabamensis* in pitcher and flower respectively.

ICPS SEED LIST
9/24/88

Capsella bursa-pastoris (non-CP); *Darlingtonia californica; Dionaea muscipula; Drosera aliciae; D. brevifolia* (1); *D. burkeana* (4); *D. burmannii* (10); *D. capensis* (N.L.); *D. capillaris* (10); *D. dielsiana* (3); *D. erythrorhiza; D. filiformis filiformis; D. filiformis tracyi* (3); *D. glanduligera; D. intermedia; D. intermedia* (Carolina giant) (10); *D. linearis* (2); *D. lovellae* (10); *D. montana* (2); *D. natalensis* (1); *D. pauciflora* (10); *D. pygmaea* (10); *D. rotundifolia; Pinguicula caudata* (8); *P. grandiflora* (1); *P. ionantha* (8); *P. primuliflora* (3); *P. macroceras* "nortensis" (2); *Sarracenia alata; S. flava* "Copperlid" (3); *S. flava* "typica"; *S. leucophylla; S. minor; S. oreophila; S. psittacina* (4); *S. purpurea purpurea* (10); *S. purpurea venosa* (2); *S. purpurea venosa* "Louis Burke"; *S. rubra gulfensis; S. rubra jonesii* (5); *S. rubra rubra* (12); *S. rubra wherryi; S. alata* x *minor* (10); *S.* x *areolata* (12); *S.* x *catesbaei* (7); *S. minor* x *rubra rubra* (3); *S. flava* x *(alata* x *flava)* (4); *S. (psitt.* x *purp.* x *minor)* x *rubra wherryi* (10); *S. purp.* x *psitt.* (5); *S. purp./rubra* x *psitt.* x *alabamensis* (3); *S. (leuco* x *wherryi)* x *(purp.* x *psitt.)* (3); *S. (jonesii* x *purp.)* x *(purp.* x *psitt.)* (1); *S. rubra* x *(psitt..* x *leuco.)* (1); *S. leuco.* x *wherryi)* x *alabamensis* (3); *S. alabamensis* x *psitt.* (3); *S. minor* x *oreo.)* x *alabamensis* (3); *S. (oreo.* x *purp.)* x *wherryi* (2); *Utricularia lateriflora* (1); *U. pentadactyla* (8); *U. uliginosa* (13).

Pat Dwyer also sent a check for $200. Great work. Kudos for Pat and for those who donated seeds.

WANT ADS

Rob Maharajh
(4 Ainslie Avenue, Hamilton, Ontario, Canada, L8S 2K2)

WTB: Fresh seed or gemnae of *Byblis gigantea, Drosera cuneifolia, Drosera trinervia* any variety, *Drosera cistiflora* varieties, *Drosera burmanni, Drosera natalensis, Drosera neocaledonica, Drosera slackii, Drosera arcturi, Pinguicula grandiflora* any variety, *Pinguicula longifolia* any variety, *Pinguicula vallisneriifolia, Pinguicula pumila, Pinguicula alpina, Pinguicula lusitanicum, Pinguicula agnata, Pinguicula esseriana* and *Pinguicula ehlersae.* Plant(s), tuber(s) or cuttings *Drosera regia* and any tuberous *Drosera.*

TS: *Drosera linearis, Drosera spathulata* varieties, *Drosera adelae, Drosera intermedia* "Carolina Giant" and "Maxima", *Drosera prolifera, Drosera dielsiana, Drosera burkeana, Utricularia longifolia, Utricularia sandersoni, Byblis liniflora* and many others. I would like to contact CP enthusiasts from around the world.

Jay Hearn
(P.O. Box 360, 62 S. Main Street, Avoca, New York 14809 U.S.A.)

Wanted to buy: Book "Pitcher Plants of Peninsular Malaysia & Singapore by Roger G. Shivas. Please send price!

ED. NOTE: Please use the following address for all future want ads.

ICPS — WANT ADS
Fullerton Arboretum
California State University
Fullerton, CA 92634, U.S.A.

SCAPE AND AXIL CUTTINGS OF *DROSOPHYLLUM*

by Richard Tilbrooke
(c/o Poste Restante, GPO, Adelaide S.A., 5000, Australia)

In the winter of 1985, I germinated my first set of harvested seeds from two *Drosophyllum* plants that managed to survive since the winter of 1984. They grew and flowered later over the summer of 1985/1986, i.e. December to February 1985-1986- a period of 3 months. In the bracteoles of these scapes, I found miniature plantlets which I attempted to root in late February and by May they were still alive.

Shane Pickford, a good friend of mine, didn't believe that they had rooted so I dug up a cutting and I found three roots about 4 cm long and about 0.5mm wide at the base. The original plants after flowering also produced plantlets in the axils of many of the leaves. These can also be used for taking cuttings. If left on the plant, they will become woody and eventually grow and mature into separate branches attached to the main stem.

To take cuttings, first hold the scape or mother plant with your left hand and the young shoot with the right hand. Gently tear away the plantlet with a downward stroke. (SEE SLIDE 2) Next, remove all leaves that have completely unfurled. (SEE SLIDE 3). Place plantlet in the pot so that only the unfurling leaves can be seen. (SEE SLIDE 4). The meristem portion is just under the soil surface.

ADDENDUM (THE ELECTROCHEMICAL MECHANISMS OF TRAP CLOSURE IN *DIONAEA MUSCIPULA)*

By John D. Degreef
6, rue Libotte, B-4020 Liege, Belgium

NOTE:

Two recent articles have brought supplementary data on the electrophysiology of *Aldrovanda* and *Dionaea*. Concerning the *resting potential,* the cell negativity of —130 mV due to selective diffusion of K+ is increased to —160 mV by a K+ pump. The latter is suppressed in winter, when ATP is scarce. Most cells of the trap, including the parenchyma's, are of the excitable type, and have similar plasmalemmas. As to the *action potential,* its peak is best explained by an outflow of Cl— *and* an inflow of Ca++. The extracellular calcium entering the cell, and the Ca++ coming out of the endoplasmic reticulum (through the action of a messenger formed by Phospholipase D) must trigger the closure mechanism. The outflow of K+ following the action potential has also been demonstrated.

SOURCES:

IIJIMA, Toshio & SIBAOKA, Takao (1985) Membrane Potentials in Excitable Cells of *Aldrovanda vesiculosa* Trap Lobes. Plant Cell Physiol. 26(1): 1-13.

HODICK, Dieter & SIEVERS, Andreas (1988) The action potential of *Dionaea muscipula* ELLIS. Planta (Berlin) 174:8-18.

ED. NOTE:

The main article appeard in the last issue of CPN (17(3): 80-83; 91-94).

Drosophyllum lusitanicum **growing bed. Photos by author.**

Cutting before stripping mature leaves.

Stripped cutting ready for planting.

Planted cutting with growing tip just under soil surface.

CP COMMUNICATIONS—CREATION OF A NEW SOCIETY PROGRAM?

by Bob Hanrahan
P.O. Box 70513, Marietta, GA 30007-0513

The full impact of the CITES regulations are now being felt by commercial CP nurseries and hobbyist alike. Unless the regulations are modified, we will have to learn to live with minimal overseas transfers of some plant material and learn to propagate affected plants within our respective countries.

To accomplish this, communications between individual CPN'ers will be far more important than it has been in the past. This report will present a concept for the society members to consider as one way to improve member to member communications.

Have you ever needed some advice about growing a certain species or genus but did not know who to turn to for advice? Did you write to one of the CPN co-editors or to a specialty CP nursery who you have purchased plants from? Were you disappointed in that the response did not come soon enough for your needs? I know from my experience that this must be the case for many of you, for I have not always been that responsive in my letter writing.

But if you knew the name, address and possibly the phone number of someone who was willing to help, would you hesitate to write or call them instead? What I am proposing to the CPN membership is the creation of a new service to members, a Communication and Information Distribution Service (CIDS) or Information Transfer Service (ITS). CIDS/ITS would be a means for you to obtain information directly and quickly from someone who lives in your geographical area. An area representative would be selected from volunteer candidates and this individual would maintain a list of CPN members interested in being part of the network. A species interest profile would be maintained on each member and used for consultation purposes. One other point, the area representative would not necessarily have to provide and answer questions, but would make referrals to someone who could be of assistance if the questions extended beyond their knowledge or experiences.

In addition to handling correspondence within his area, the area representative would submit a quarterly report to the CPN co-editors highlighting local questions, small talk and generally what is happening in the region with CP and the hobby. The short paragraph reports would be published in CPN collectively in each issue.

Specifically, the purpose and intend of the program would be to:

Improve communication between members

Allow members to learn of each others existence in the same region

Reduce the amount of correspondence your co-editors are asked to respond to each year

Foster the creation of local CP gatherings and bog-hops (field trips)

Expand the CPN "News & Views" section to include the events from the worldwide membership on a consistent basis.

This list could continue, but I am sure you get the idea. The number of area or regional representatives needs to be considered. Initially, a minimum of one rep each for Australia, Canada, Europe and Japan would be required. Language related and membership concentration factors could easily alter the number of representatives. The U.S. could position a representative in the Northeast, Southeast, Midwest/Central, and Pacific regions to start the program.

I am using this open forum approach to initiate some creative thinking from CPN's highly intelligent membership. I present a very basic start of something different for you to ponder over and improve on. A new name other than what I have presented would be a most welcome beginning. If you have some ideas (pro or con) on such a service, please write to me and let me know your thoughts. I will collect, summarize and forwward our combined ideas to the co-editors for their consideration as a new service from the Society. ——→

LITERATURE REVIEW

Crouch, I.J. and J. Van Staden. In vitro propagation of *Drosera natalensis*. S. Afr J. Bot. 54(1): 94-96 1988

When a modified Murashige and Skoog medium supplemented with various hormones was used, clones of this *Drosera* species budding from the explant tissue could be subcultured on defined media and then hardened off.

Debbert, P. Two new *Drosera* spp. from Cape Province, South Africa. Mitt. Bot. Staatssamml. Muench. 23(0): 431-436 1987

Two new species, *Drosera admirabilis* and *venusta* are proposed and described.

McNally, S.F., A. Stewart and U.E. Wilson. The stimulation of acid phosphatase activity in the stalked gland of *Drosera rotundifolia*. Ann. Bot. (Lond.) 61(3): 289-292 1988

In comparing stimulated and unstimulated tissue, some acid phosphatase activity was localized in vacuoles, cell wall regions and cuticular pores of only a few cells. When stimulation occurred longer than 24 h, additional activity was noted in most gland cells which suggested that there was a new synthesis of acid phosphatases during this time period.

Ng, P.K.L. and R.P. Lim. The taxonomy and biology of the nepenthiphilous freshwater sesarmine crab, *Geosesarma malayanum* Ng and Lim, 1986: *Crustacea, Decapoda, Brachyura, Grapsidae* from Peninsular Malaysia. Malay. Nat. J. 41(2/3): 393-402 1987

This crab lives in the fluid of the cups of the pitcher plant *Nepenthes ampullaria* and the authors describe its habits compared with other phytotelmic crabs from South America.

Turnbull, J.R. & A.T. Middleton. A new species of *Nepenthes* from Sabah, Malaysia. Bot. J. Linn. Soc. 96(4): 351-358. 1988

A *Nepenthes macrovulgaris*, a low mountain meadow species from Mt. Silam is described and illustrated.

SPECIAL ANNOUNCEMENT

REBECCA HAUSER, 12½ Hill St., Apt. B, San Francisco, CA 94110.

I've attempted to order carnivorous plant seed over the past few years, and thought you might be interested in the following updates for your 1988 source list:

CARNIVOROUS GARDENS OF BRISBANE, QLD 4110, Australia has gone out of business, I think in May or March of this year.

EXOTICANA SEEDS of Greytown, South Africa has not responded to several requests for listings in the last two years.

MARSTON EXOTICS has been incorporated into Lawnsdown Nurseries Limited, Veldifer Lane, Kings Acre, Hereford, England, HR4 7AA. Some of the more seldom found plants and books are no longer offered.

RENATE PARSLEY, I am happy to say, is still in business, offering a small listing of interesting *Drosera* seed, but at the following new address: 1 Woodlands Road, Somerset West, 7130, South Africa.

I hope you find the above information useful. Some of these small businesses can be hard to keep track of!

(Editor's Comment)

To insure that the results of this program concept can be included in the March-1989 issue of CPN, please send all comments directly to Bob Hanrahan, 2130 Meadowind Lane, Marietta, Georgia 30062 U.S.A. before January 21, 1989.

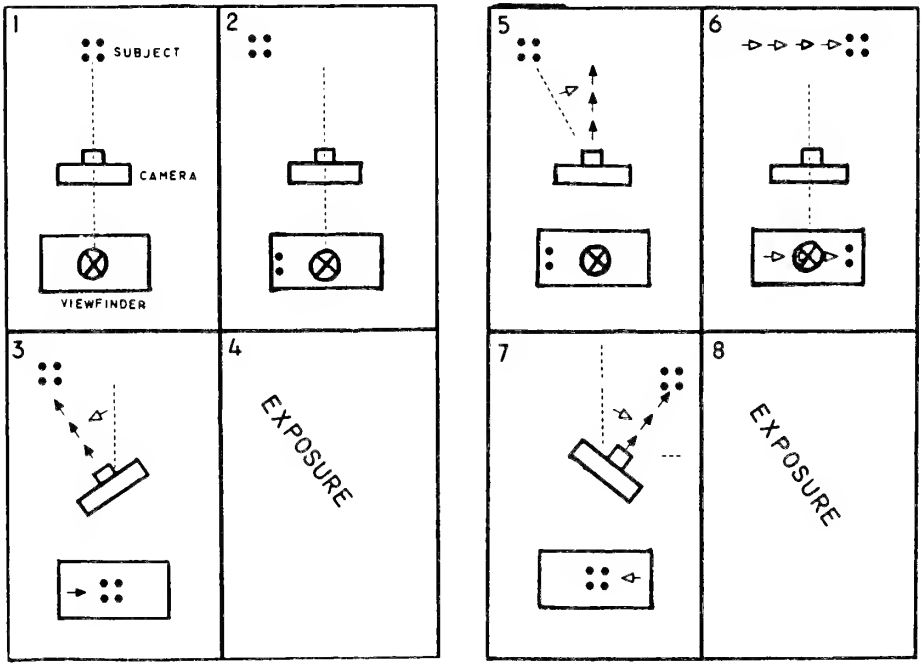
DEPTH WITH PERSPECTIVE 3D PHOTOGRAPHY

by Richard D. Tilbrooke
(c/o Poste Restante, GPO, Adelaide 5000, S.A., Australia)

A prerequisite to three dimensional photography is depth of field extension. This process as I use it involves two 35mm slides to create a fuller representation of the subject. In each slide a different angle and plane of focus is chosen so when viewed together using two slide viewers, the two complement each other and a deeper depth of field is obtained along with three dimensional effects.

Unless one has access to lenses with better than f16 reciprocity, a subject such as pygmy Droseras can pose a great many problems. Very often, focusing on the stipulate crown of a rather tall pygmy *Drosera* results in the rosette being out of focus, and vice versa. Consequently it is advantageous to try the following technique. Make a slide focusing on the rosette of traps and another (without moving the camera) whose focus centers on the crown. When viewed together using a pair of small viewers (one for each eye), they will be superimposed so that an average of the two images is perceived by the brain. The focus of the average image is not as sharp as either of the two sister slides, but the depth of field is improved.

True 3D photography when done correctly allows you to send a true representation of your plants around the world. There is one great advantage with this technique: Views unable to be witnessed by the naked eye can be achieved with a camera! How close can you hold a match to your eyes so that it is possible to see it sharply still and in perspective? For me it is about three centimeters from my forehead; but with a camera the limit depends only on your equipment, time and patience.



In order to photograph your subject in 3D, place it in the center of your camera's viewfinder (it is best if the camera is mounted on a tripod). Move the camera right or left (see accompanying diagrams 1-8) so that the center of your original view now just eclipses one edge of your viewfinder frame by about half. Rotate the camera on the spot to bring the subject back into the viewfinder center, focus, and then make your exposure. Reverse all procedures so far taken for the second slide. The camera should once again squarely face the subject so that the image appears centrally in the viewfinder. Now move the camera in the opposite direction so that the subject eclipses the other edge of the viewfinder image by about half. Once again, rotate, focus on the subject and make an exposure. After film processing, you should have a 3D slide pair.

Each of the two slides in a pair should now be labeled "right" or "left" depending on what angle you have used as shown in figures 1-8. Be certain these are accurate (follow a set procedure or make notes while photographing), and that both slides are oriented as to backing or emulsion side. These can be viewed by placing each slide into two inexpensive slide viewers that are held up to the light for viewing (eg Afga). Manipulate the two slide viewers around until the left slide being seen by the left eye and the right slide being seen by the right eye blend into one 3D image. This takes some practice at first, but after the first set it is easily accomplished thereafter.

This process will give you realistic depth at about 10-30 cm. from the subject. For closer images, say with bellows, begin by moving halfway across the viewfinder image and experiment from there. For macrophotographs it is better to move the subject than the camera. (In some cases, pots can be more easily slid across accurately as in figures 1-8 rather than moving the camera on its tripod).

I can assure the readers that if you have not been interested in *Utricularia* bladders up until now, wait until you see them in 3D! If this is not enough and you want to go the full hog, then you can also try depth of field extension while focusing on your 3D subject.

I am sure that you, like me, will receive great joy from even your first slide pair. If, however, you feel uncertain as to the benefits of this marvelous medium, then I will gladly lend slide pairs from my modest library to those who already have two viewers or to those who wish to purchase a pair of viewers from me. I can supply a pair of viewers for $15.00 (Austral.) which covers purchase, postage and packing to anywhere in the world.

EDITORIAL NOTE—

After receiving this from Mr. Tilbrooke and seeing some of his slides, we knew we wanted to present 3D CP photography to our readers. But how? It was obviously impractical to make enough slide pairs copies for all subscribers, so we had to figure out some way to use the printed page. Joe Mazrimas finally came up with the mechanism. If you follow his instructions, you can see 3D in these photos accompanying this article!

INSTRUCTIONS

Place your nose on the page between the left and right picture and slowly pull the page away from your eyes forming a third image in the middle between the pictures. Try to ignore the right and left images and concentrate on the third image which is at first out of focus. Try to focus this third image holding the page about 15 to 18 inches away from your eyes. In about 10 to 30 seconds, a new, in focus, image will suddenly appear which will now have a 3-D look to it. Hold the page very steady when focus is achieved. People who wear contact lenses or have astigmatism may experience some difficulties in doing the above gymnastics with their eyes.


CEPHALOTUS
FOLLICULARIS


CEPHALOTUS
FOLLICULARIS


REGIA

ON THE CULTIVATION OF *DROSERA LINEARIS*

by Richard Shomin
983 Barney, Flint, MI 48503 (313) 239-4742

The best way to begin cultivating any plant is to study its natural habitat, especially if that plant is difficult to grow. The only reason why any plant may be difficult to grow is that the grower is not meeting the conditions for that plant which depends on the grower's budget, knowledge and determination. The enjoyment of growing a desirable plant lies in making an environment economically and requires little attention.

First of all, I would like to relate some observations on two marl fens with *Drosera linearis,* one in southeastern lower Michigan and one in northeastern lower Michigan. In the winter the hibernacula survive the cold January temperatures with a possible freezing depth of 12 inches, based on the ice fishing in the southeast area. The marl flats develop a thin layer of ice, but I find that standing on them is unyielding to my body weight suggesting that the marl is also frozen.

So much for one temperature extreme. I have found temperatures much higher than some sources suggest for growing the species. I have field notes on marl and air temperatures that I have taken throughout the summer of 1988, though not complete. *Drosera linearis* can take the heat, especially in southeastern lower Michigan. The first ten days in July of 1988 high temperatures were at or near 100° F. On one of those days the marl temperature was 93° F and the air temperature one inch above the marl was 105° F. However, this did not bother the plants at all.

In the summer the plants were exposed to direct sunlight most of the day in both locations and grow as clumps and separately in both locations. In the southeastern fen I found some *Drosera linearis* at the base of mossy hummocks along with a few plants of sterile *Drosera anglica,* but these plants did not grow on the hummocks but I also found a few pioneering plants on the open marl. The northeastern location *Drosera linearis* grow on the marl flats and on some of the hummocks as well. *Drosera linearis* grows on the short, isolated hummocks, but does not grow on the thicker hummocks along the edge of the fen. The *Drosera linearis* on the hummocks grow just as vigorously as the ones in the nearby marl. Is this *linearis* able to compete with the faster growing vegetation of the hummocks? Is this a case of "typical" *linearis* and "competitive" *linearis* with intermediates, or are the short hummocks growing slow enough and able to hold seeds better than the marl and thus have the appearance of preference?

I have had limited success growing this species outdoors in my area. During the winter of 1987-88 the hibernacula were brown-green and were frozen during January and February. By mid-April they turned bright green and started growing. I was using marl as a growing medium in undrained plastic pots and my water supply is rainwater which at the time was very clean; it was collected during winter thaws. Then by early summer I compared the culture plants with the wild and concluded they did not grow as vigorously as the wild plants. The plants in culture needed watering daily and this left me with the impression that this periodic raising and lowering of the water table stressed the plants. In their natural habitat the seep water flows at a somewhat steady rate keeping the water table a constant level. *Drosera linearis* does not need precipitation to survive. During the drought of 1988 the plants were doing just fine with their only source of water coming from seeps. On the other hand, if a thunderstorm passes over dumping three inches of rain, that extra water will quickly drain through the fen's natural drainage system.

To keep the water table constant in culture attempts, I came up with an apparatus shown in Figure 1, which I had constructed by August 1988. Even if I am wrong about a changing water table stressing the plants, the apparatus I propose is a practical way of growing the

plants and requires less attention. The two inner tubes support the entire weight of the support frame, pots, soil and plant. I have tested the mechanics of this system without plants and will try growing these plants next year with some results by next autumn (1989).

The reason for two inner tubes is that if one deflates the other will float the system. If you plan on using a fine grade of dolomite or marl, I recommend 1 square inch of siphon cross-section area for every 16 square inches of soil surface area. The response to changes of water table depth is acceptable.

On a fair weather day the water flows from the reservoir to the marl to replace the evaporating water. If it rains and there is an access of water in the culture, the water flows from the culture to the reservoir. You may put a drain hole 1 centimeter above the marl so that the plants aren't submerged to a greater depth for too long.

This self-adjusting system takes about 12 hours to bring the water table back to normal after a heavy rain. The occasional drainage from the pot has the benefit of reducing the soluble mineral content that might have built up. The reason it takes this long is because the marl behaves as a clog. However, the flow is slow but sure. The water level should not be more than 2 centimeters below the surface of the marl as estimated from the natural habitat.

My siphon is made of glass for easy inspection to see if it is working. After a period of time gases may build up in your siphon rendering it inactive. The siphon recharging tube is a practical way of recharging your siphon without disturbing the soil and plants.

To recharge the siphon simply plug the end into the reservoir, remove the stopper and fill with clean water, and then put the stopper back on. Make sure it has a good seal. Do not worry about gases in the recharging tube. It's when the gases get into the siphon proper that you have to recharge.

Water quality is also a very important factor in growing this species. By mid-July I found that rainwater collected after a long drought is too dirty or nutrient-rich for *linearis*. Use only the cleanest rainwater - toward the end of a long rain, or if it also rains the very next day that water should be cleaner than the previous collection. Let the water stand for a week, then look for color in the water and any film on the surface. The water should be clear with no film

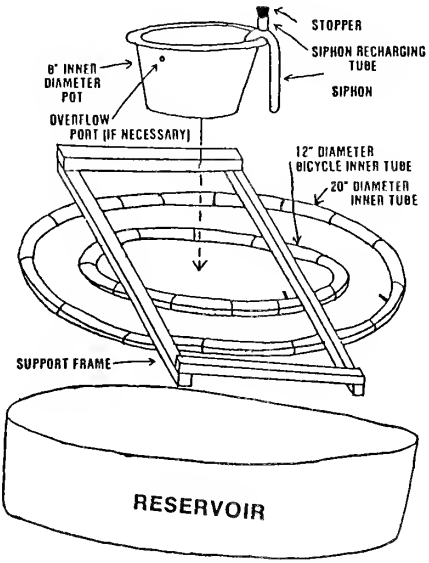


FIGURE 1

CP IN A SOUTHEASTERN MICHIGAN FEN

S. purpurea in a *southeastern Michigan fen.*

Drosera linearis **in a southeastern Michigan fen. All photos by author.**

on the surface. There will always be some sediment from rainfall, so after using nearly all the collected water shake up the collection vessel and dump the remainder, and prepare for the next collection of water. If you don't want to gamble at all and pay a little more for it, use distilled water. You could build a solar still to be economical.

Use chickenwire around your reservoir so that the birds don't use it as a bird bath and contaminate your water. You also need a sieve to keep bugs off the surface of the water. If you want to grow the plants in peat moss using this method that's an experiment left to the reader. The parts of this apparatus are inexpensive and should be inspected annually for cracks in the inner tubes.

Finally, I found a marl fen in southeastern lower Michigan that has a large population of *Sarracenia purpurea* but does not contain *Drosera linearis*. This fen is now public land and there is evidence that it was once exploited for its limestone. It has two marl flats that look like they could support *Drosera linearis*. I am considering transplanting some plants and seeds to this location. If the plants grow and reproduce, they may possibly have grown there once before. If they do not grow there, then either they never did, or possibly the aquifer is contaminated because of human development. If they do grow there they have a better chance than threatened habitats on private land that I have seen. I would hate to see *Drosera linearis* eliminated from southeastern lower Michigan. It would mean a longer trip for me to go see them, and possibly the loss of a genetically different plant than those of upper Michigan and the northern tip of lower Michigan.

Fortunately, this fen is secluded and not accessible to the casual wanderer such as the average person on a Sunday picnic. Deerflies and mosquitos will be enough to turn most away. If that is not enough, peat muck, poison sumac and massasauga rattlesnakes might be the final discouragement.

The other thing—a constant water table might be a difference between good growth and luxurious growth of acid bog CP. I have seen some of the local kettle hole bogs that have *Sarracenia purpurea* and *Drosera rotundifolia* that are larger than my culture plants which are in undrained pots. The floating sphagnum mats in these bogs assure that the water table of these plants is constant no matter if it is a dry year or a wet one.

Acknowledgements:

I would like to thank Frederick W. Case for these locations and hints of what to look for in finding fens.

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FOR THE RECORD

In Barry Rice's article "A Varying Lighting Scheme and Its Effects on Some Easily Grown CPs" which appeared in the September, 1988 issue of CPN, the plant referred to as *D.* 'Lake Badgebup White Flower', was incorrectly identified. According to Barry, it is actually *D. pygmaea.*

BOOK REVIEW

by Donald Schnell, CPN Co-Editor

CRUM, HOWARD. 1988. A FOCUS ON PEATLANDS AND PEAT MOSSES. University of Michigan Press, Ann Arbor. 306 p.

The true CP enthusiast usually expands from a narrow interest of acquiring plants and growing them using standard methods to study of the environment in which they are found. This reviewer has spent many hours in various peatlands in which there was not one CP in sight, but I still had a great and productive time just enjoying and studying the peatland.

I can recommend this book without hesitation to all those who are interested in learning more about peatlands, particularly those in the broad Great Lakes area and upper midwest generally. The author's primary interest is bryology, (study of mosses and liverworts) but this has taken him to many peatlands and his accumulated experience, research and knowledge of these areas comes through clearly in this book along with a great affection for the areas, even when hip deep in a false lake bottom!

The first 200 pages or so of the book covers peatlands in general, and the author dives headlong into the mire of confusion regarding naming and classification. He discusses bogs, fens (rich and poor), marshes and swamps and carefully defines his concepts of them and points where he differs from others, or even from concepts that apply more closely to other parts of the country (eg Maine) or even of the world (British Isles, Sweden, Germany, etc.). His focus tends to return to the Great Lakes area. The terms ombrotrophic, eutrophic and dystrophic are put into perspective, and other wetlands such as lakes, seeps and mires are correlated, and terms such as strings and flarks are carefully described.

Throughout the book are great numbers of very well printed black and white photos, charts, tables and especially useful and superb line drawings. I cannot say enough about the line drawings which meet the botanical art criteria of sharply illustrating important diagnostic points in an artistically pleasing and balanced presentation. Higher plants were drawn by Marie Wohadlo, and sphagnum drawings by Constance Butley.

The entire book is interesting and informative but I was especially impressed by the chapters on plant/peatland relationships (which presented a photo/drawing flora by Wohadlo), the chapter on nutrient cycling which is written quite understandably and is far more complete than similar discussions in general biology and botany texts and most ecology works I have read, the chapter on bog exploitation for medical, heating, horticultural and other commercial reasons, and finally the pages in the book beyond p. 200 which present what is to me the first clear lead into understanding taxonomy of *Sphagnum* spp. Dr. Crum eases one's apprehension and says it can be done, tells how to do it, then presents keys, good descriptions of each species, and Butley's drawings of each species, one to a page with the whole plant, branches, leaves, pore and retort cells, pertinent histologic structures, spores, etc. Many people may not realize that various Sphagna are highly adapted to niches and microhabitats of each kind of peatland.

The actual mention of CP is confined to Great Lakes species (except for *Dionaea)* with about a page and a half of text, and the superb photos and line drawings. But this should not deter the beginning or amateur CP enthusiast from adding this book to their library as a ready source of pertinent peatland information.

The book concludes with an excellent glossary, an index, and a bibliography of 286 references, many as recent as 1987.

The flyleaf suggests this is the first entry into a projected series called GREAT LAKES ENVIRONMENT edited by Warren H. Wagner, Jr. We look forward to ensuing books.

The book is available in hard and soft cover. Write the University of Michigan Press, Ann Arbor, MI 48106 for price, postage and sales tax information.

THE EVOLUTION OF *ALDROVANDA* AND *DIONAEA* TRAPS

John D. Degreef, 6, rue Libotte B-4020, Liege (Belgium)

The classical model:

Many authors have noted the resemblance between *Drosera* tentacles and the sticky protective glands found in many plant species (LLOYD, pp. 4-5).

Adrian SLACK, in his 1979 book 'Carnivorous Plants', and **Dr. B.E. JUNIPER,** scientific adviser to a remarkable Oxford Scientific Film (1986), thought that *Drosera* traps could derive from such protective devices. The existence of sticky glands on the flower scapes of many *Drosera* species seems to confirm this interpretation.

Ivan SNYDER (1985) went a step further and showed how a *Drosera* leaf could have transformed into a *Dionaea* trap. The tentacles would have lost their stalk, except for the ones on the rim which transformed into the marginal teeth, and the ones that became sensory hairs. The trap could lose its tentacles when the closure movements had become sufficiently rapid.

Dr. JUNIPER (1987) was skeptical about the origin of the marginal teeth, and pointed out that their vascularization is different than tentacles.

Fossil evidence:

The oldest pollen from the family *Droseraceae* is *Droseridites parvus* from Assam (N.E. India) (SAH & DUTTA, 1974), which dates from the Paleocene (65-55 MYA). This is the period just following the extinction of the Dinosaurs (and of many other animal groups). At the time India still was a large island covered with rich tropical forests. These (and *Droseridites)* were destroyed when the continent drifted into the arid climatic zone. We therefore cannot say much about this find, except that the *Droseraceae* seem to be the oldest carnivorous plants: pollens of *Nepenthaceae* and *Lentibulariaceae* only appear during the Miocene (23-5 MYA).

Eocene sediments (55-38 MYA) have yielded pollens belonging to two different *Droseraceae* genera.

The first, *Saxonipollis,* is *Aldrovanda*-like. CHANDA (1965) has indeed shown that the pollen tetrads of each of the four present genera of the *Droseraceae (Aldrovanda, Dionaea, Drosera* and *Drosophyllum)* have a specific and recognizable structure.

Aldrovanda's Eocene ancestors occupied a large range, from the two species which grew near London (CHANDLER, 1964) and *Saxonipollis saxonicus* from East Germany (KRUTSCH, 1970) to *"Aldrovanda" unica* and the somewhat larger *"A." kuprianovae* from Priangarje, near Lake Baikal in Central Asia (KONDRAT' IEV, 1973). This corresponds well with part of the present range of *Aldrovanda vesiculosa.* Contemporary Africa was separated from Europe and Asia by the Thetys Sea (TERMIER & TERMIER, p. 301), and *Saxonipollis* probably did not get there. The Northern portion of the North Atlantic opened up fairly late, and it does not seem impossible for *Saxonipollis* to have reached North America in late Cretaceous, Palaeocene or early Eocene times. Some mammals did *(ibidem,* pp. 295-297), taking advantage of the climate in arctic North America and Europe, which was temperate yet maybe too cold for *Aldrovanda: Metasequoia* and *Credneria* forests then covered Greenland and Baffin Island *(ibidem,* p. 295). There were also faunal contacts between S.E. Asia (including the regions around Lake Baikal ?) and the Rocky Mountains *(ibidem,* p. 302).

The second Eocene genus belonging to the *Droseraceae* was recently discovered in Australia: *Fischeripollis halensis* from the Hale Basin, dating from the Middle to Late

Eocene (TRUSWELL & MARCHANT, 1986). The *Dionaea*-like pollen of this genus had previously been found in later, Miocene sediments from Germany.

The Australian find is quite exciting. The only modern *Droseraceae* genus in the Southern Hemisphere is *Drosera*. These regions had not been as severely hit by the Glaciary periods as the Northern continents, and it does not seem likely that entire genera belonging to the family we are dealing with could have become extinct. So *Fischeripollis halensis* would appear to be an ancestor of the Australian *Drosera*. Because of the resemblance with *Dionaea* pollen, another *Fischeripollis* must have produced the genus *Dionaea* of which only one species remains.

One must be aware that the fossil evidence is too scant to allow definitive conclusions. But one thing it does not show is *Drosera*-type plants to be older than *Dionaea* or *Aldrovanda*. The problem is complicated further by the fact that leaf evolution is more rapid than the evolution of pollen (and flowers). A plant with archaic *Fischeripollis* pollen thus could already have possessed true *Drosera* traps, long before the regular *Drosera* pollens finally appeared during the Miocene. There are indeed palaeogeographic arguments for the development of *Drosera* tentacles in late Cretaceous times.

Evidence from the modern plants:

With the fossil evidence being so inconclusive, one has to turn to a careful examination of the anatomy and physiology of modern *Droseraceae*.

Aldrovanda vesiculosa L. is a strange plant which has been considered as a relict from the Tertiary ever since KORZSCHINSKY's 1887 publication. Its flower is strictly pentamere (five sepals, petals, stamens, styles and placentae). This is the expected ancestral structure of a *Droseraceae* flower which in most other species has become more or less modified. DIELS (1906) also pointed out the many common characteristics between the *Droseraceae* and regular waterplants. *Aldrovanda* has been a waterplant for a long time: its embryo never even attempts to produce a primary root (LLOYD, p. 196) and its vascular system is much more atrophied than for example in the *Lentibulariaceae* (which appeared during the Miocene). The germinal aperatures of the *Aldrovanda* pollen grains possess an operculum which is unique in the whole family (SAHASHI & IKUSE, 1973). This confirms that this plant's ancestors have split off from the main body of the *Droseraceae* at a very early date, probably Cretaceous. If this the most primitive member of its family is an aquatic, is it not possible that all archaic *Droseraceae* were waterplants? And if the flower structure is primitive, could this not apply to the trap also?

How could such a trap have evolved? If we look at the trap's "hinge", we can see that the epidermal cells are elongated, with their long axis parallel to the midrib. The apex of the hinge carries two or three nasty looking imbricated teeth, and the abaxial surface of the whole midrib bears a number of bifid glands. On both sides of the midrib, the trap lobes are seen to be formed of three cell layers: the adaxial and abaxial epidermis and the large turgescent parenchyma cells. The long axis of all these is *perpendicular* to the hinge. The rim of the lobes features a row of unicellular teeth with a large aqueous vacuole and a diminutive nucleus (FENNER, 1904 p. 366). The two epidermis carry trichomes, some of them identical with the ones on the outside of the midrib, others more specialized (but the initial embyrology of all these is the same).

Now there are structures in the same plant which look very much like the midrib of the trap: the setiform appendages which surround the trap and are said to protect it against floating debris. But this function does not seem to explain the presence of unicellular teeth on the setae. At the apex we find the same kind of imbricated thorny structures as on the midrib. The setae carry bifid trichomes (also present on most other surfaces of the plant). The long axis of the cells is parallel to the axis of the setae.

Could the *Aldrovanda* trap not be a much broadened seta with specialized features? We may then picture the ancestor of *Aldrovanda* as a waterplant with cuneate leaves, these carrying between 7 and 9 setae (as shown by regressive leaves, to be discussed later). The

"path to carnivory" was not as difficult for such a plant as one may imagine. Waterplants are rootless, and since their epidermis is covered with an impermeable waxy cuticle, they have to absorb water and solutes through their trichomes. These possess a porous cuticula and an endodermoid layer analogous to the one which controls the entrance of substances in roots. In *Aldrovanda* the bifid trichomes are abundant on the juvenile leaves which, together with the growing point, already possess a cuticula (CASPARY, 1859 p. 129). These hairs respond to chemical stimulation in the same manner as the digestive glands in the mature trap or as the glands of *Drosera* tentacles (FENNER, p. 378). An adult plant contains only about 20 milligrams of dry weight (KAMINSKI, 1984), so most of its volume is water, which has to enter the plant. These hydric needs are greatest during the volume increase associated with growth, hence the trichomes on the leaf buds. The trichomes then tend to fall off. The last ones to do so are situated in two significant areas: near the midrib on the abaxial side of the trap, and on the same side at the level of the abaxial capitate (digestive) glands (FENNER, p. 373). These two sites must use more water than elsewhere, the former during closure (a growth phenomenon with a volume increase), the latter either to produce digestive secretions, or to keep the osmotic pressure of absorbed substances under control (DEGREEF, 1988 p. 35). An alternative explanation is that the trap is the last structure to mature.

With water slowly flowing between the setae of the trapless prehistoric plant, organic debris may have accumulated there. The small teeth on the setae may have enhanced debris getting entangled. Organic substances could then be absorbed if two conditions were satisfied: first of all, digestive enzymes would have to be secreted into the debris. Secondly, the digestion products would have to be prevented from escaping. Thus plants with a broader seta featuring slow folding movements would be selected out.

Enzyme secretion in *Aldrovanda* has not been clearly demonstrated yet, but is likely to exist here as it does in the three other genera. The secretion must be produced by the specialized capitate hairs, which also have been shown to be the site of absorption of digestive products (FABIANGALAN & SALAGEANU, 1966). Their increased number of cells, the buttressed cell walls of these (containing a labyrinth of the plasmalemma as in *Dionaea?)* vastly augment the absorption surface. Some of the trichomes specialized in detecting the presence of debris, and later of animals. They lengthened and acquired a sensory hinge. It should be stressed that sensitive trichomes are the rule rather than the exception in the *Droseraceae.* The numerous stellate hairs on the *outside* of the *Dionaea* trap have been shown to produce action potentials upon stimulation (DIPALMA et al., 1966). The sensitive portion of the *Drosera* tentacles is the gland (DARWIN, through LLOYD, p. 140), which really is a trichome perched on top of the stalk, i.e. an expansion of the leaf blade (botanically: an "emergence"). The series of action potentials which cause the tentacle to curve originate in the gland head proper (WILLIAMS & PICKARD, 1972). The gland heads in *Drosophyllum* may also perceive stimuli, although these do not lead to any kind of movement (FENNER, p. 104).

Trap closure itself must be brought about by very rapid growth of the abaxial epidermis. This mechanism is now accepted for *Dionaea,* for *Drosera* and even for the slow "narrowing phase" in *Aldrovanda* (LLOYD, p. 203). It seems that time has come to abandon the old ASHIDA model involving turgor changes (still accepted by IIJIMA & SIBAOKA, 1981 & 1982). Turgor changes do exist, but seem secondary to momentary water shortage *after* closure.

Growth phenomena triggered by action potentials (such as those produced in the sensory hairs of *Aldrovanda* and in the stellate trichomes of *Dionaea)* were eventually discovered in other plants also. An example is the seedling of *Bidens pilosus* L. where the stimulation of the cotyledons causes action potentials which inhibit the growth of the hypocotyl (DESBIEZ *et al.,* 1983).

The traps of *Dionaea muscipula* ELLIS seem to resemble the ones of *Aldrovanda* very much. The chromosome numbers of the two species—32 and 48 respectively (BEHRE, 1929;

KRESS, 1970)—are multiples of 8. But we have seen that *Aldrovanda* is taxonomically somewhat remote from the three other genera of the *Droseraceae*. The flower structure shows that the closest relative of *Dionaea* (quite surprisingly) is *Drosophyllum*. This is an element in favor of the classical hypothesis which interprets the *Dionaea* trap as a modified *Drosera*-(or rather: *Drosophyllum*-) like leaf. But the main element which led to this theory is the resemblance between the marginal teeth and the sensory hairs of the Venus' Fly Trap and stalked glands. Does a closer examination confirm this second point?

The marginal teeth lack any remains of an apical gland or of an endodermoid layer. Their vascular system contains both xylem and phloem in contrast with *Drosera* tentacles which only contain the former. This is not a decisive point though, because *Drosophyllum* stalked glands contain the two types of vessels (and also conductive cells like the ones in *Aldrovanda).*

I see another problem in identifying the marginal teeth with emergences. These latter first appear as small pimples on the previously smooth juvenile leaf bud. Then they elongate to their adult shape as has been well demonstrated for *Aldrovanda* setae (CASPARY, 1859 & 1862). *Drosera* and *Drosophyllum* tentacles (FENNER, 1904). But in 1986 I observed the occurrence between several marginal teeth of the same *Dionaea* trap of a lace-like network of leaf tissue, apparently branches of the vascular bundles. Does this imply that the teeth are not formed like emergences, i.e. by cell proliferation away from the leaf surface; that instead they originate by resorption of strips of tissue between them which when incomplete would leave a network between the adult teeth? Upon close examination the teeth's lateral rims are sharp and slightly irregular as in leaves where tissue resorption is known to occur, e.g. the familiar house plant *Monstera (Araceae),* and unlike the nice rounded sides of the marginal tentacles in *Drosera.* Comparing the abaxial side of the rims of *Dionaea* and *Drosera* traps shows them to be quite different.

Could the vascularization of the teeth not give us more clues? LLOYD's plate 18 fig. 1 seems to show major branches abruptly cut while going towards the empty spaces between the teeth. This would be in favor of the resorption hypothesis. But having checked seedling and adult traps of different sizes, I have not been able to confirm this drawing: the main bundles appear to go more or less straight into the teeth. The bifurcations going towards the spaces between the teeth are small and of the same type as the ones seen leaving large veins elsewhere.

Decisive evidence will only be brought forward by a thorough study of the embryology of the trap.

There are similar questions concerning the sensory hairs which are also considered as modified tentacles (SNYDER, 1985; JUNIPER, 1987). This identification is apparently confirmed by the presence of a layer of cells with impermeable, cutinized cell walls just distally from the sensory hinge (HABERLANDT, 1906 p. 12). This could be a vestigial endodermoid layer (WILLIAMS, 1982). Such a structure is known in roots and at the base of glandular trichomes. The special cell walls force the substances entering and leaving the roots or the glands to pass through the cytoplasms so that their flow can be exactly regulated. In *Drosera* and in *Drosophyllum* the gland (a modified hair) with its endodermoid gate is perched on top of an expansion of the leaf blade (the tentacle stalk). Now in *Drosera* the sensitive area of the tentacle, the site of origin of the action potentials which lead to the bending of the stalk, is known to be the gland. So we would expect the sensory hinge of the *Dionaea* trigger hair to lie distally from the supposed vestigial endodermis. But we know that it is situated proximally instead! There is an elegant solution to this problem which is to consider both the distal cutinized cell layer *and* the sensitive cells as a greatly modified endodermis. The cell walls of the sensory hinge do contain cutin, but only in the form of strange granules (HABERLANDT, 1906 p. 32) for which no interpretation had hitherto been given (as far as I know). This would confirm the hypothesis by WILLIAMS & PICKARD (1974, pp. 13-15) that the actual structure producing action potentials in the *Drosera* tentacle is the endodermoid layer.

This leaves us with almost all the cells of the sensory hair deriving from a trichome and its endodermoid layer. The only equivalent of a tentacle stalk would be the lower part of the footpiece, which is not much of an emergence!

So the marginal teeth and the sensitive hairs are not very convincing as tentacle equivalents, and this leaves us without an evolutionary model for the *Dionaea* trap.

Fortunately, a lot of information can be gained from regressive leaves which appear in unfavorable conditions (this is a general principle not only in the *Droseraceae).* Many *Drosera,* even those with forms as exuberant as *D. binata* LABILL., revert to ancestral spatulate, roundish or simply forked leaves as can be seen in juvenile plants (LEAVITT, p. 202), or with the first and last leaves of the season (CLEMESHA, 1972). In *Aldrovanda* the trap inhibits the formation of the setae which we have seen to be archaic leaf parts. During the development of the leaf the lateral setae, i.e. the ones furthest away from the inhibition by the trap bud, appear first (CASPARY, 1858 p. 721). When a group of leaves is inhibited by the presence of a flower bud, no (or smaller) traps are formed. This allows the production of an increased number of setae *(ibidem,* p. 718). In the large variety 'Duriaei' CASPARY, which grows in S.W. France and can yield plants of up to 60 centimeters with large traps, the number of setae is decreased *(ibidem,* p. 722). The juvenile pitchers of *Sarracenia* are all very much alike, and the same thing happens in plants which are not grown in ideal conditions. One may think that the buds produced under those conditions just do not develop, but in reality they may truly revert to an ancestral morphology. They sometimes even produce structures which their ancestors possessed and which were subsequently lost. Thus the pitchers of a young axillary rosette of *Nepenthes ampullaria* JACK do have a waxy zone with the characteristic deformed stomata under a narrow peristome (as I have observed). In the adult, the peristome broadens into a slippery infundibulum, thus eliminating the need for a waxy zone. And indeed, the glandular area now occupies the whole interior of the pitchers.

During the winter, or in young plants, or sometimes when growing conditions are not right, *Dionaea muscipula* produces abnormal leaves, too, the extreme forms of which do not even possess a trap. The rim of the distal portion of these "petioles" is toothed. In extreme conditions strange outgrowths also appear which look a little like cabbage leaves (a photograph in PIETROPAOLO, J. & P.A., 1974 p. 44). So what we have here is a cuneate leaf with marginal teeth (which could have been longer in the past) and a strange network of ridges. Even if the latter were covered with sticky glands and if the leaf margins could slowly fold around a capture, the purpose of the ridges would be hard to explain in a plant growing on land. But if the *Dionaea* trap developed under water like the one in *Aldrovanda,* these structures would be useful. Organic debris would get entangled in the marginal teeth and in the outgrowths. The latter would also carry glandular trichomes, and the presence of ridges would increase the total secretion and absorption surface. In mutants able to close faster, live prey could be captured. Only then could some of these plants leave the water. The closure mechanism with its narrowing phase would press the glands tightly against the prey after capture. The ridges, which had been useful to increase the contact with the shapeless organic muck caught by the archaic traps, would now become unnecessary. They would disappear from the sophisticated pinched-off distal portion of the leaf, which we call the trap.

Even in the old saprophytic leaf the trichomes must have differentiated into digestive glands, sensory hairs and the capitate glands of the leaf margin. The latter now secrete a syrupy solution which I have noted to give a positive reaction for glucose. They could be modified mucous glands which once sealed the trap when it closed under water. Similar glands exist in *Aldrovanda.* The enzymes transforming simple sugars have been demonstrated in *Drosera* gland cells during the early phases of mucous synthesis (DEXHEIMER, 1978 p. 51). The membranes of cell organelles are often included in the plasmalemma, so it would not be astonishing to find enzymes for sugar transport relocated there, too.

The subaquatic trap evolution hypothesis presented here takes into account more data than the classical theory. Its main drawback is that no similar evolutionary patterns are known in other waterplants, whereas the alternative- sticky protective glands- is not

infrequent. But tentacles exist in the aquatic *Podostemonaceae* (DIELS, 1906). If a chance mutation had allowed these to secrete digestive enzymes, they may have become carnivorous, too. The early stages of *Utricularia* evolution may also have been similar with the ones presented. here.

Although this is not significant, we may add that in nature the *Dionaea* trap seems to work well under water too. In the Fifties, Patricia R. ROBERTS and H.J. OOSTING from Duke University discovered the remains of aquatic animals (Planarian worms, May fly larvae and even small newts) in the traps (ZAHL, 1961).

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INSECT-EATING PLANTS AND HOW TO GROW THEM

By Adrian Slack
Alpha Books 1986

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It is truly difficult to find fault with a book as marvelous as this, a publication carnivorous plant enthusiasts have long been waiting for. Many hobbyists have considered Mr. Slack's 1979 *Carnivorous Plants* their "bible", but this book, already out for a few years and still rare in some countries, renders pages of previous horticultural supplements found in other CP books obsolete. Mr. Slack has composed a neat and tidy little book, bursting at the seams with information. It should reign number one among the shelves of collectors for quite some time to come.

Of course the thrill of *Insect-Eating Plants* is the subtitle *And How To Grow Them.* As Mr. Slack explains in his introduction, his first book was a biology of CP, while this publication is dedicated solely to their culture. The author passes on vast information on hundreds of varieties now in cultivation from many seasoned growers from around the world, including his own quarter of a century of experience. Mr. Slack's love of these plants leaps out at you, and his engaging style is captivating from the start. The book is well organized, to the point, colorful, and fun to read.

There are over 60 pages of photographs in this volume, all in color and many by Slack himself. Most are startling in their beauty, and offer visual feats of rare CP such as:
Please see **PLANTS** on page 126.

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PLANTS continued from page 125.
Sarracenia X 'Daniel Rudd', one of the author's many creations and considered his favorite; Robert Cantley's haunting *"Nepenthes rajah* with frog"; *Sarracenia flava* 'Burgundy'. Slack's own line drawings are a handsome addition, particularly of the *Nepenthes.*

Perhaps the most accomplished feat of Mr. Slack is the transformation of the carnivorous plant hobby from an obscure and curious novelty to a mature horticultural art form. If Slack has his way, no longer will CP be confined to black plastic pots hidden in greenhouses: they will boldly decorate household windowsills, add color and intrigue to the garden, and find their status elevated to the heights of the African Violet, as Slack confidently predicts for the *Pinguicula.* His designs of outdoor bog gardens are clever, and the decorating of pots of sundews with tufa rock, for example, show taste and creativity. His seriousness shows a much needed discipline in the world of CP, as when he claims "that, as with the rose, the horticultural future of *Sarracenia* lies mainly with hybrids", or his belief that only one of perhaps 3000 hybrid seedlings might be elevated to the status of cultivar. His opinions punctuate the text often amusingly in that already familiar Slack style: "... and the unspeakable-sounding and unspeakable-looking *S. X umlauftiana* . . . " Indeed! He attempts to clear up some misconceptions as well, as in the cultivars *S. flava 'Maxima'* and *S. X willissii.*

There are a few typographical errors, but even these are overshadowed by the attractive format of the book. While Slack complains of lack of space limiting his description of *Sarracenia* hybrids, more than half a page is left stark blank at the end of the section, where much desired text could easily fit. A nice addition would have been some more words on public displays, flower shows, and societies, for this is how the hobby gains recognition. And why didn't the author or publisher advertise the publication of this fine volume in, for example, CPN? There has also been some confusion on where to order the book.

Nonetheless, no enthusiast will be disappointed in this little gem, and as the hobby grows, one hopes we can look forward to future volumes on even more detailed subjects by Mr. Slack, such as a book exclusively on the sundews and butterworts, or one fully dedicated to the pitcher plants. So it was with pleasure to hear that *Drosera 'Highland Red',* a sundew discovered by Frank Woodvine and popularized by Slack in this book and through his Marston Exotics, was named by Martin Cheek in his description of the plant as *D. slackii,* a nice compliment to a man who has done so much in the popularization of these wonderful plants. This book is still available from:

University of Washington Press
P.O. Box 50096
Seattle, Washington 98145 $19.95 (800) 441-4115

Artist, Author, Correspondents and Photographer Index

Title Index

Coming in 1989

- CP of Auyan-Tepui in Venezuela.
- Tuberous *Drosera*
- Early history of *Drosera* and *Drosophyllum*
- Evolutionary patterns in *Drosera.*