CARNIVOROUS PLANT NEWSLETTER

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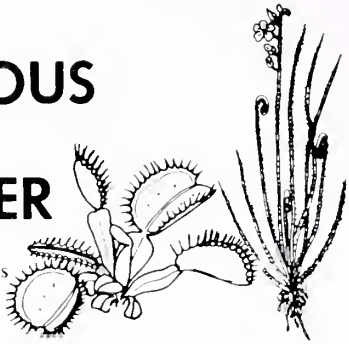
Official Journal of the International Carnivorous Plant Society



Volume 11, Number 3
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COVER

Sarracenia purpurea ssp. *purpurea*, in a cranberry bog near Manorville, NY. By Paul Connor. See Dec. CPN for details.

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 Mrs. Pat Hansen, c/o The Fullerton Arboretum, Dept. of Biology, California State University, Fullerton, CA 92634. DO NOT SEND TO THE CO-EDITORS. Checks for subscriptions and reprints should be made payable to CSUF FOUNDATION-ARBORETUM.

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 Dec. issue is Nov. 1, 1982.

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News and Views

BRUCE BEDNAR (25 Lake Court Loop, Ocala, FL 32672) sent these comments on the range and density of *S. leucophylla*: "*Sarracenia leucophylla* is, in my eyes, the finest looking of the North American pitcher plants and perhaps one of the most successful, although if you were looking for it in the eastern part of the range you might not know it. The eastern colonies begin just northeast of Tallahassee, plants are few and not conspicuous. Then southwestward, the plants pick up along the coast sporadically in Franklin county. Also along the coast west of Panama City as well as inland along some of the two laners, small stands hang on side by side with *flava* and *psittacina*. Leucos stay fairly scarce until you get near East Bay near Pensacola. Then the shy *leucophylla* becomes a bold dominant plant. Multi-acre stands become common sights. The only leuco-albas I've ever encountered were just off the Interstate in Santa Rose county. The absence of red from the green and white pitchers make them very striking, and the three plants stood out considerably over the thousands of red-green form.

"As you pass over the Florida-Alabama state line, you encounter what seems to be the epicenter of this plant. As far as you can see—*leucophylla*, billions, endless fields of bright colored pitchers. These massive stands are common in Escambia County of Florida and Baldwin County of Alabama, then pick up again some 40 miles north of Mobile in Washington County. They continue into Mississippi, then lose their identity, and are overcome by alata."

HARRIS EMMONS II (824 McGilvra Blvd. E., Seattle, WA 98112) says: I am bewildered at the absence of Northwest entries to *N & V* in Vols. 6, 9 and 10. I would like to get in touch with Seattle CPers to trade plants and discuss growing CPs outdoors in Seattle's "unique" climate.

For your information, there is a collection of CP in the University of Washington's Parrington Hall greenhouse that could be quite excellent if given a little help.

SEED BANK*

Patrick Dwyer (St. Michael's Episcopal Church,
49 Killean Park, Albany, NY 12205)

$.75 per packet

Darlingtonia californica, Dionaea muscipula, Drosera aliciae (pale) (5), *D. burmannii* (2), *D. capensis, D. capensis* (narrow leaf), *D. capillaris* (2), *D. indica* (3), *D. intermedia, D. linearis, D. montana* (5), *D. montana* (white flower), *D. peltata, D. pigmaea* (3), *D. rotundifolia, D. rotundifolia* (Oregon) (5), *D. spathulata* (Kansai), *Nepenthes gracilis, N. khasiana, N. mirabilis, N.* × *mixta* (1), *Pinguicula caerulea* (5), *P. lutea* (10), *P. vulgaris, Sarracenia flava, S. leucophylla, S. minor* (10), *S. purpurea purpurea, S. purpurea venosa, S. psittacina* × *minor.*

*For instructions on how to send or order seed, see CPN March 1982, page 4.

JIM POWELL (2524 Denning Lane, Chesapeake, VA 23321) sent the following activity note. An informal group of North Carolina ICPS members is meeting regularly.

On April 4th twelve members of the International Carnivorous Plant Society were the invited guests of a local timber company to search for and collect CP on their private property in the Green Swamp. The property is slated for plowing and tree planting. What a day it was—beautiful in every way—the sun was shining and the winds were strong enough to keep even the bravest mosquitoes down. Our guide for this outing was Mr. Stanley Rehder of Wilmington, NC.

We began our search in an open area several hundred acres in size. Our finds included *Sarracenia flava, purpurea, rubra,* and *Drosera capillaris* and *intermedia.* After about one and a half hours, we moved on to Nature Conservancy land to view the CP there and have a quick lunch. While there, a number of our group toured an old Indian site and found some pottery pieces from years gone by. We also added to our list of CP seen, *Dionaea muscipula* and *Pinguicula lutea.* Another site on Conservancy land produced what we think might be *Utricularia subulata.* Only two small yellow flowers were found.

We said goodbye to our guide and thanked him for the day. Before returning to base camp we discovered a large savannah in which hundreds of *Pinguicula lutea* were in bloom. Here too were *P. caerulea*—fewer in number, but equally beautiful. At this site, Ron Gagliardo found, to the envy of all, a large *Sarracenia* hybrid.

Ten of our group camped out that weekend. Old acquaintances were renewed and new friends made. Bill Carroll was overhead to say, "It's the most fun I've had in years!" I personally learned to say *Drosera* correctly and to recognize *D. capillaris* and *D. intermedia* on sight. We discovered that CP grow on the side of the ditch that gets the morning sun; And, the other side—though not six feet away—has none. *Dionaea* and *Pinguicula* grow side by side in the sand. *Drosera capillaris* grows in wet sand and *D. intermedia* will grow in the water.

Oh yes! One other discovery—as a group, we know a lot more about CP than we do about camping—and we loved every minute of it!

GREG RUSSELL (71 Melrose Drive, Flindersview, 4305, Qld., Australia) notes: It is well known that *Nepenthes mirabilis* shows great variation in Australia to the extent that at the beginning of the 20th century, an Australian botanist, F. M. Bailey, found what he believed were up to eleven species in Queensland. On further investigation by B. H. Danser, it was found that they were only forms of *N. mirabilis.*

Recently, I added a very unusual form of *N. mirabilis* to my collection. It was collected along with other seedlings from Northern Queensland about two years ago. The plant has retained the seedling characteristic of not having a true tendril. The leaf blade does not form a tendril but narrows and continues down into the pitcher to link up with the frontal wings.

The plant is now approximately three feet tall and all the leaves show this characteristic. In the upper pitchers, the leaf blade narrows to about half-inch wide and unlike other *Nepenthes* attaches to the front as in the lower pitchers. These upper pitchers may just be intermediate pitchers with true upper pitchers forming as the plant obtains more height. The lid on all pitchers does not stand erect but lies over the peristome. This structure does not interfere in its trapping ability for it traps ants in considerable quantities.

The plant is flowering at present (May '82) and is male. I have pollinated a *N. mirabilis* grown from seed collected in the same area in which the winged form was found. Hopefully, I will produce the winged-tendril characteristic in the offspring. I have heard rumors of a winged-tendril form of *N. rafflesiana* existing in

(Continued on page 78.)

Once In a Lifetime

by David W. Taylor

As the giant DC-10 thundered down the runway at London's Heathrow airport and up into the evening sky of a summer's day in late July, I sat strapped in my seat thinking of the adventures that lay ahead of me in the mysterious lands of Malaysia.

I had decided nine months before this day, to become one of a party of people to join an organized visit lasting three weeks, to study the flora and fauna in selected regions of Malaysia, including four days on the slopes of Mount Kinabalu. This very place was the prime reason for my decision to go to Malaysia, for it is well known by botanists and plant enthusiasts as a botanical paradise and a mecca for the carnivorous pitcher plant *Nepenthes*. It was my desire to see and record some of these strange yet fascinating plants and bring back a photographic account of my experiences.

The whole flight to Kuala Lumpur was to last for seventeen hours, and although I tried to sleep, the excitement of the journey prevented this. However, I eventually nodded off, if only for a half hour, and continued to snatch short moments of sleep for the rest of the long and arduous flight.

The first thing that struck me as the party walked out into the air at Kuala Lumpur airport was the tremendously high humidity. I was certainly relieved to climb aboard the small air conditioned fifteen seater bus that was to take us to our first hotel, situated on one of the main roads in the centre of the city. It was shortly after 12:30 a.m. as the bus began to drive along the roads of Kuala Lumpur from which I could see the many small shops and various industries of this bustling capital of Malaysia.

The Taman Negara National Park, situated in western Malaya, is a very large area of natural beauty with many square miles of jungle to explore. As it can only be reached by river transport, we had to drive to the river's edge covering many miles of dusty roads, stopping once for a Chinese lunch, and once again in a very scenic area known as the Gombac Pass, to view a Malaysian roadside market.

Eventually our bus reached the river after having taken us through some beautiful and interesting countryside, a journey lasting over three hours, and on roads that were very bumpy and full of pot holes. It was a pleasure to get off the bus and stretch our legs before embarking on a one and a half hour river trip aboard power assisted long boats, that were to herald the true beginning of a Malaysian adventure.

Sailing down river in a longboat was my idea of peacefulness, and watching the exotic birdlife, and the large majestic butterflies fluttering across the water, added to the enjoyment.

It was towards late afternoon when the boats finally arrived at the landing station of the Taman Negara NP, and it was a great surprise to everybody to find just how modern the chalet accommodation was. The whole area was of great natural beauty, with many colourful trees and shrubs. I will always remember the splendour of the very large double flowered bouganvillea which one always had to pass either into or out of the camping site.

The following morning, I was awakened just before 6:00 a.m. by the sounds of birds, and particularly the distant hooting noises of gibbons. Their noises are more prominent in the early morning, as this is when they are engaged in establishing their territory. They were certainly making quite a din of this on my first morning in the Taman Negara.

After a good European breakfast, served up by two delightful young Malaysian girls, I joined some of my new found friends that I had made from the party, and went on my very first jungle

walk. Dressed in a cotton shirt and shorts,, with a hat perched on my head, and my camera equipment on my shoulder, I could hardly wait for the exploration to begin. The jungle was dense in places, and there were quite a number of deep gulleys to cross. Most of the gulleys were bridged by felled tree trunks, or more usually by man-made bamboo foot bridges.

Although the canopy of tall trees sheltered us from the hot sun, below this canopy, the ground was very wet. Because of the continual evaporation of the wet ground and undergrowth, the conditions in the jungle were very humid, and my clothing soon became wet from my own perspiration. The jungle floor was covered with fallen leaves and twigs, and every now and then there were to be seen great armies of termites and ants all marching in convoy over the leaf-littered ground, and disappearing into the dense undergrowth. There were some ants that measured nearly one inch long.

Everywhere I looked in the Taman Negara there was greenery, but strangely a lack of flowers, although the few that were seen were very spectacular. There were some trees like the *Baccaurea* tree that were in fruit, and these hung down all around the trunk of the tree like great strings of large peas.

The walk lasted for about three hours, and I was very weary as I trundled out of the dimly lit jungle and out into the heat of the midday sun. A change of clothes was called for as I reached the protection of a comfortable chalet, and it was only then that I saw that my left ankle was covered in blood that had soaked through my once-white sock, and had started to congeal in places. I had had my first leech attack, and it was to be the first of four such attacks in my stay at the Taman Negara. These horrible little worm-like creatures live underneath the carpet of rotting leaves on the jungle floor, and they can smell blood at more than a foot away.

Another first for me on this day was to be caught in a tropical thunderstorm. I actually like thunderstorms, and I was hoping to experience one while in Malaysia. The rain really pelted down, and I took great delight in watching it from the shelter of my chalet veranda. Nightfall is early in Malaysia, but even so, there are still remarkable things to be seen if you are keen enough to walk the jungle with a torch light. The *Barringtonia* tree was well worth the walk that I took with several other members of the party, that led us about three hundred yards into the black interior of the night time jungle. The astonishing beauty of the pendulant individual flowers of the *Barrintonia* can only be seen at night when the flower opens and is pollinated by moths. After everybody had taken photographs of the flowers, we shone our torches back along the jungle trail, and headed back to our chalets. On the way back we spotted the rump of a small mouse deer as it nosed its way through the jungle thicket.

After the excitement and adventure of my first day at the Taman Negara, I could hardly wait for the following day to begin, and although I felt very weary, I managed to stay awake long enough to write my diary notes. I certainly slept very well that night, but I was still disturbed from my sleep by the hooting gibbons the following morning. After breakfast, it was down to the river's edge to board power assisted longboats for a trip down river to another part of the jungle. The short journey was to be full of excitement, as to get to our destination meant having to shoot the river rapids. I found it necessary to cover only my camera and binoculars, as the spray drenched everything and everyone.

The day was spent exploring the various trails in the jungle, and it was on this day that I felt that I could have made good use of a small tape recorder. The sounds of the jungle were all around me. The sounds of insects and birds seemed to bring the jungle to life, and at

one stage, I stood along and just listened to the noises around me. All of a sudden there was a crash in the trees, and as I looked up, I just caught a glimpse of a very large bird flying off to a safer position. I later discovered that what I had seen was a toucan.

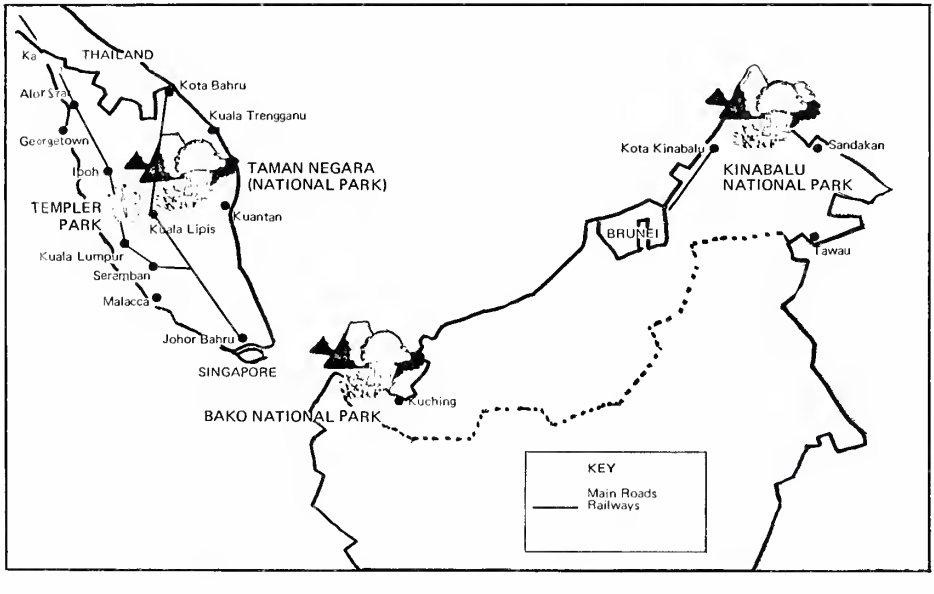
The return journey back to the campsite took us through the rapids once again, and as the boat hit the swirl, a great blanket of water hit me full in the chest. The sun warmed the water that drenched me, and I was thankful to get back to the chalet for another change of dry clothing.

After four days in the Taman Negara, it was time to pack our belongings for the long and tiring journey back to Kuala Lumpur where we were to stay for just one night before flying to Kuching, the capital of Sarawak. The river trip from the campsite still contained adventure, as my boat suddenly became grounded in the soft silt of the river bed. We had strayed into shallow water, but the young Malaysian park rangers that always ferried us on the river trips soon had us out of trouble.

Another thunderstorm greeted our arrival back at Kuala Lumpur, but we were soon in the shelter and comfort of the hotel, where it was nice just to be able to relax for a while before our evening meal and packing for our departure the following day. I felt very tired towards late evening. I had spent most of the day either propped up in a boat, or cramped in a mini bus, and I was happy to be able to stretch out in the real comfort of a firm bed.

It was only a short bus ride to the airport at Kuala Lumpur, and it was not too long before we boarded the Boeing 737 jet airliner for the flight to Kuching. On arrival there, it was just another short bus ride to the jetty of the Sarawak River, where we climbed aboard a fairly large pleasure boat. The leisurely trip up river was interesting, particularly as we passed by some tribal villages. Men were fishing with nets in the river's edge, while the women were washing clothes. Although they were all very busy, they certainly had time to wave to us as we sailed by. Eventually the boat sailed out into the expanse of the South China Sea, and it was not very long before we sighted our destination which was the Bako National Park of Sarawak.

It was a midafternoon as our pleasure boat drifted into the narrow channel of



water at the edge of the park, and finally came to rest in a mangrove swamp. There was a sandy beach to cross in order to get to our accommodation, and I found this very tiring as I had to try to carry a very heavy suitcase and my camera equipment. Every now and then, I stopped in order to change hands, and eventually I reached the chalet that we were to stay at during the next four days. The chalets were very basic, and nothing like the more up-to-date accommodations that we were afforded at the Taman Negara. However, we soon settled in and after a meal some of us began to look around the place. The air was very humid, more so than in Malaya, and I wondered just how hot and sticky it would be the following day. The area was full of life, and during the evening we watched the antics of geckos, moths, and praying mantis, all of whom adorned the walls and ceilings of the chalet.

The chalet that I shared with the other male members of the party was very uncomfortable, and because of the humidity and broken down bunkbed, I ended up with having a restless night. The sounds of crickets, moths, and mosquitoes kept stirring me from sleep, and the hardness of the bed made me ache. However, the thoughts of adventure the next day kept my spirits high.

The new day soon began, and after a pleasant breakfast prepared by our young female cook, it was decided to explore the immediate vicinity. We started out shortly after 8:00 a.m., and after a very tiring uphill climb through dense forest that literally blotted out the sky above, we eventually walked out onto a high plateau. The ground here was covered with large slate grey rocks that felt hot when touched. This was not surprising as the area was very open, and the sun blazed down, parching the tops of trees and drying out the ground beneath. A sudden call from one of my colleagues made me forget the sudden heat, and I walked to where he was standing at the foot of a tree which stood all alone in the fierce sunshine. The thin trunk was gnarled and twisted—in fact the tree looked dead to me. My gaze was suddenly directed to the ground around the foot of the trunk, and there I saw my very first *Nepenthes* pitcher. It was a ground pitcher of *Nepenthes rafflesiana*, and it measured about nine inches long. The beautiful crimson colouration made it stand out from the dry grass it lay in, and as I knelt down to examine and photograph this remarkable sight, I felt a tingle of excitement come over me. I had travelled thousands of miles to see these strange plants, and this was to be the first specimen of how many more I wondered. I photographed the ground pitcher, and then looked up into the head of the tree. There sprawling in amongst the dry branches was the different shape of the aerial pitchers of the plant, and the very top pitcher had reached a height of around ten feet. Quite a lot of curiosity was caused by the discovery of the *Nepenthes* plant, as most of the other members of the party had not heard of the plant, let alone seen one. I found myself giving a short explanation of the species and their curious carnivorous habit, which made everybody concerned very interested—so much so, that they all started to look for the plants among the trees and shubbery.

It was not long before I found another species of *Nepenthes* on the plateau. This time it was *Nepenthes gracilis*, and there were many plants situated on both sides of the narrow footpath that we were tracking. The light green pitchers measuring an average four inches long were hanging from the twiggy branches of what only could be described as bracken. It was a dramatic sight to see these great clusters of pitchers hanging there like decorations on a Christmas tree. The plants were growing in extremely dry conditions, although the air was very humid. Further along the track, I observed some of these plants growing in almost pure sand. I had taken a number of photographs, and had written records of the plants. Just ahead, the open land of the plateau gave way to a rain forest

Nepenthes ampullaria
Bako National Park of Sarawak

Photos by D. Taylor

Nepenthes rafflesiana
Bako National Park
of Sarawak

Nepenthes rafflesiana
Bako National Park
of Sarawak

land of the plateau gave way to rain forest, and I began to wonder what was in store for me as I quickened my pace and set my sights on the mass of green forest. Some of the party were beginning to tire, and the journey back across the plateau in the merciless sunshine was a daunting prospect for us all.

The rain forest was a welcome retreat from the hot plateau, although as I entered into the canopy of trees, I was instantly aware of the much wetter atmosphere. There was a lot of healthy greenery, particularly ferns, and everywhere I looked, there was interest. I had not been in the forest very long when my eyes fell on a splash of pale green pitchers that looked more like little lobster pots. They were the pitchers of *Nepenthes ampullaria*, and further exploration brought forth more clusters, some of which were very large. The plants were very abundant in the forest, and obviously preferred the very wet and humid conditions that only a sheltered environment could afford. The temperature in the dense rain forest was measured at 80° F. (27° C.), and the relative humidity was also 80 percent.

When it was decided to return to base, I felt a little reluctant to leave the forest, but I too was beginning to tire, and so we started the long walk back through the trees and the creeping vines, and out onto the plateau once more. We walked at a steady pace, and very soon were in sight of our chalets. Our very thoughtful cook had arranged lunch for us, and as we trundled into the clearing where the chalets were situated, she greeted us with the news that she was making a very large kettle of tea for us, which certainly lifted my spirits. I drank five cups of tea during that late afternoon, and as I relaxed in the chalet, I thought back to my travels that day and to those amazing *Nepenthes* plants that I had seen and photographed.

It was suggested that the entire following day be spent exploring the terrain of the Bako National Park. Unfortunately, there was much reluctance from most of the party about spending a whole day in an area that no one knew anything about, and eventually only four of us decided to go. As we set out the following morning, the four of us were confronted by a small tribe of monkeys that were always paying visits to the chalets for scraps of food. The leader of the tribe took great offense when we tried to photograph him, and showed his teeth when he became blinded by our flashguns.

As we rejoined our footprints from the previous day's walk, I was pleased that I had taken every precaution for this new walk. Our very friendly cook had supplied us with food and fruit, and I made sure that I had a full container of pure water. Another requirement on these long walks was an aerosol of insect repellent. A once-over spray of skin and clothing usually insured protection from insect attack during the day and, judging from the size of some of the flies and mosquitoes, spraying oneself was a habit worth adopting.

We very soon found ourselves back in the tropical rain forest, and I was once again in with the *Nepenthes* plants. The *Nepenthes ampullaria* were all over the place, sprawling this way and that, and inviting closer inspection. One of the most remarkable sights I saw was a very large and beautiful pitcher of *Nepenthes rafflesiana* sitting right in the middle of a clump of *N. ampullaria*. Another *N. rafflesiana* pitcher was seen sitting upright by the side of the track looking as though it was begging for food. It was at least nine inches long and was so perfectly formed that it looked like a piece of sculpture. There were many similar sights such as this in the rain forest, and as time slipped by, I began to wonder how many miles we had walked. I had fitted my belt with a pedometer, which is an instrument for measuring one's walking pace, and a glance at this showed me a walking distance of just over four miles. We were feeling quite tired, and we decided to give ourselves another half hour before turning back.

We must have taken a different path on our return journey through the forest, because we suddenly found ourselves in a beautiful tropical paradise, with tall palms, crystal clear water, and a serenity that beckoned the weary traveller to stop and rest for a while. This is just what we did, and we spent a very restful half hour at this beautiful place. The only sounds here were of the water cascading over smooth boulders into a small lake at a lower level. The whole area was surrounded by the forest, and the large palms and ferns were reflected in the water, which was only a few feet deep.

It was a pity to leave this wonderful place which really looked like something out of a Tarzan adventure film. However, we had to make the break as time was getting on, and we did not want to get trapped by nightfall. The walking became hard because we were so tired, but eventually we got back onto the plateau, and I knew that then we were only an hour from base. There was a cheer as the four of us staggered up to the chalets and dropped wearily onto provided chairs. My small pedometer registered nine and a half miles, and it certainly felt like it. I was thankful once again for the tea kettle, and as I drunk my fourth cup, I felt satisfied that I had achieved more than I had hoped for by making the long trek into the fascinating rain forest of Bako.

The long and tiring walk coupled with the uncomfortable bunk bed left me incapable for anything the following day, so I decided to do some photography, starting at the nearby mangrove swamp, and working backwards. I think that the day's biggest excitement was the sudden appearance of a large monitor lizard, that crawled out of the undergrowth and made straight for the food scraps that had been thrown out for the monkeys. It was at least four feet long, and its arrival made the monkeys scatter in all directions.

The time had come to pack our belongings in time for an early afternoon departure back to Kuching, so I hurriedly got all my things together, and took my case and photographic gear up to where everybody else in the party had put their belongings ready for the walk to the boat. This gave me time for a last minute walk onto the sandy beach of Bako and a look at a small clump of *Nepenthes gracilis* which was actually growing on the edge of a cliff top, looking out to sea.

We boarded the boat at 2:00 p.m. and sailed out onto the South China Sea. It was not long before we were back on the Sarawak River, passing by shanty looking fishing villages, and waving to the native children as they stood waist deep at the river's edge. I was looking forward to our next day, as it was on this day that we were to fly to Koto Kinabalu, and on arrival at Kuching, were told that the flight was to be very early in the morning. A quick calculation made us realize that we would have to rise by 5:00 a.m. to get breakfast in, so it was decided to have an early night. After having spent three uncomfortable nights in the bunk beds back at Bako, the soft hotel bed at Kuching was sheer luxury, and I was sorry to have to get out of it in the darkness of the following morning. After breakfast, we boarded our bus for the drive to the airport, and as the Boeing aircraft soared into the sky, I began to dream of the days ahead of me, knowing that I had at least reached the climax of my Malaysian adventure. I would soon be on the slopes of the famous Mount Kinabalu, a mountain which is well known to botanists as a mecca for *Nepenthes*.

(To be continued.)

Special Notices

An extra plant source not mentioned in the March 1982, *CPN*: Marston Exotics, Spring Gardens, Frome, Somerset, England.

Catalog is 50 pence and they prefer to supply Britain and Europe.

Correction for entry for Plant Shop's Botanical Garden in CP Source List:

Catalog: $2.00 deductible with order (note price change).

The Most Dangerous (Looking) Nepenthes

by Cliff Dodd II, c/o The Aku Tiki Inn
2225 S. Atlantic Avenue, Daytona Beach, Florida 32108

If you want to pick a carnivorous plant species to stir man's interest in the terrifying (a large interest if one considers current movie fare), many would pick *Dionaea muscipula*, the Venus' Fly-trap, with its fast moving 'steel-trap' jaws. However, tucked away in the Far-eastern jungles lives another candidate which, though capable of no movement must surely be one of the most bizarre of carnivores: *Nepenthes bicalcarata*.

This rare Pitcher Plant is unique in many ways. Its appearance is certainly a shock and must have fascinated early explorers of N. Borneo. Projecting from the back of the lid are a pair of thorns resembling the fangs of a snake about to strike. Their function is far from clear but they seem to play no part in catching the plant's insect prey. Burbidge believed them to be a device to prevent small insectivorous animals from stealing the plant's meals, (1). Whatever their function (or lack of it) they are merely metamorphosized ribs of the peristome, the pitcher's corrugated mouth. (See photo, back cover.)

This peristome, which has very closely set fine ribs, and the arrangement of the inflorescence in a loose panicle, led Danser to name *N. ampullaria* as its closest living relative, (2). There are however some important differences: *N. ampullaria* has a short petiolate spathulate leaf shape, a small reflexed lid, and is rather densely covered with fine hair on most of its vegetative parts. By contrast *N. bicalcarata* has deeply petiolate leaves, a broad lip covering the mouth, and is lacking in hair. *N. ampullaria* forms numerous rosettes and does not produce upper pitchers on its climbing stems, while rosettes are unknown in *N. bicalcarata* and the plant forms well developed upper pitchers. In general the species resembles the more widespread *N. rafflesiana*.

In the wild *N. bicalcarata* has a symbiotic relationship with a species of ant which drills out the hollow thick tendril where it joins the pitcher to use for its home, (3). What benefit the plant receives, if indeed any, in unknown. Though I know of no information on the subject it seems likely the ant is a carnivore which hunts the insects drawn to the plant and probably not a nectar feeder, otherwise it too would likely end up as the plant's prey.

Cultivation

I have had plants of *N. bicalarata* in cultivation for less than one year. Rumor had it that the plant could not be rooted from cuttings and this has proved false in my experience. What has been the case seems to be a hormone problem: some cuttings developed roots but would not break any dormant buds. Other produced leaves but no roots. Out of twenty-five cuttings only four rooted and began producing new growth and so far only three of these have pitchered. One, kept in a greenhouse over winter in fairly low light levels produced first a green pitcher, then with more light in spring a pale orange one. The largest plant under 24 hour Gro-lux produced yellowish leaves but blood-red traps with white tipped fangs. This plant has since joined the first and it is too early to tell if this color difference is genetic or induced by the constant light. Indeed the cuttings may have been taken from the same plant.

The plants are in a typical *Nepenthes* soil mix consisting of Sphagnum moss, vermiculite, fir bark, and a small amount of peat. Having not been rooted long,

(Continued on page 73.)

Nepenthes bicalcarata
Dried pitcher shows hollow tendril, reniform lid and fangs.
Photo by R. V. Zillins

Nepenthes bicalcarata pitcher.
Photo by Steve Smith

From
SINNESORGANE IM PFLANZENREICH

by Gottlieb Haberlandt

V. Insectivores: *Drosera* and *Drosophyllum*

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We must thank Charles Darwin (1876) for much of our knowledge about the behavior of insectivorous plants. In the case of the species of *Drosera*, his investigations established with greater accuracy than ever before, the sensitivity of the tentacles of these plants to both mechanical and chemical stimulation. Such stimulii cause the stalks of these tentacles to bend inward, and a chemical stimulus has a longer lasting effect than a mechanical one.

Nevertheless, the tentacles are extraordinarily sensitive to contact. Even a small piece of human hair, 0.203 mm long and weighing 0.000822 mg, caused the tentacle stalk to move when placed on the gland (Darwin, 1876).

Darwin further established that mechanical stimulation requires a body to contact the surface of the gland itself.[1] The body must, therefore, first penetrate the drop of mucilage covering the gland. He believed that excitation resulted from stationary pressure. Pfeffer (1884) corrected this notion by noting that, as with tendrils, frequently repeated stroking or friction with a solid body is necessary for stimulation. The individual strokes need not be strong, indeed, they may be quite weak: even the vibrations caused by rearranging furniture in the laboratory will suffice. The tentacles of *Drosera* bend more strongly the longer such stimulation continues; but stimulation lasting only three seconds had a noticeable effect in the case of very sensitive specimens.

The mechanical and chemical sensitivity of the tentacles is exclusively confined to the secretory cap (Fig. e). The stalks are not sensitive. This is particularly worth mentioning because the small multicellular papillae which occur on the stalks might possibly be taken for perception organs for mechanical stimuli. But Darwin (1876) had already explained these papillae, which, by the way, occur

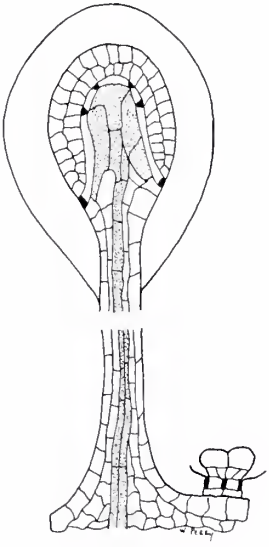
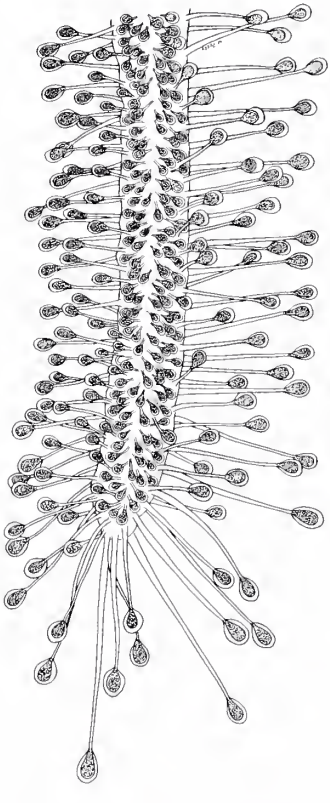


Fig. e. Longitudinal section through a tentacle and a sessile gland of *Drosera capensis* L. The secretory cap is the double layer of cells just beneath the mucilage coat over the tentacle head. Haberlandt believed these were sensory cells. His drawings of individual cells of *Drosera* tentacles are of cells in this layer. The layer between the secretory cap and the stippled cells is the endodermis and the stippled cells are the vessels of the xylem which connect with the vascular system of the leaf. There are two layers of stalk cells surrounding the xylem, an epidermis and a layer continuous with the leaf mesophyll. The drawing is by Wayne Perry.

on the entire surface of the leaf, as absorption organs, and O. Rosenberg (1899) also agrees with this view in his detailed work about the absorption processes of the *Drosera* leaf.

For this reason, we expect to find probable organs of perception for mechanical stimulation of the tentacle only on the small secretory caps, and more particularly, on their surface cell layer[1]. We must, of course, remember that the small secretory caps perform very diverse functions: they secrete abundant mucilage and the digestive enzyme, they perceive mechanical and chemical stimuli, and finally, absorb the decomposed substances. All of these different functions are carried out in the glandular layer of the cap.



A 2.5 cm long tip of a *Drosera capensis* L. leaf. Figure e illustrates a longitudinal section through one of the tentacles and one of the sessile glands which would occur over the flat surface of the leaf between the tentacles. This drawing is by Wayne Perry.

It is therefore necessary to proceed carefully in the interpretation of the details of its structure.

Because of the agglomeration of the various functions, it seems wise first to examine the tentacle, or secretory cap of one of the Droseaceae, which is not sensitive to mechanical stimuli, and whose tentacle stalks do not move when stimulated. One such plant is *Drosophyllum lusitanicum*, a low undershrub with long, lineate, grooved leaves, with two types of glands: stalked "tentacles" and sessile, disk-shaped glands on both sides, but especially on the underside (Fig. f). Opinions differ as to the function of these glands and the division of labor existing between them. Darwin believes that the acid, very sticky secretion of the stalked glands is not secreted more abundantly after chemical stimulation. He also believes that the secretion has only a slight digestive ability. On the other hand, the glands absorb their own secretion very quickly when they are mixed with a small quantity of a nitrogenous substance[2]. Neither after chemical nor after mechanical stimulation do the tentacle stalks move in the slightest. The sessile glands only begin to secrete when they are chemically stimulated, but it is mainly this secretion which has digestive properties and causes a rapid decomposition of the insect bodies. Goebel (1891) essentially agrees with Darwin's conception. But while he considers the stalked mucilage-secreting glands to be mainly for the purpose of trapping prey, he attributes the secretion of the digestive enzyme primarily, if not exclusively, to the small sessile glands.

Arthur Meyer and A. Dewevre (1894) have arrived at another conception. They consider the stalked glands to be the actual digestive glands, but admit also that the sessile glands have an influence on the digestion. "The probable reason that the small glands cause the protein to go into solution more quickly is because they are responsible for removal of decomposition products." These

authors then interpret the sessile glands simply as organs of absorption. In my opinion, the reasons for which they assert this are not convincing. It is mainly the following experiment which convinced them that the sessile glands do not secrete enzymes. The mucilage of the stalked glands was very carefully removed from a certain region of the leaf, so that no mucilage from the large glands came in contact with the sessile glands. When egg albumin and small pieces of meat were placed on the small glands and observed, secretion did not take place. The meat and egg albumin dried up and finally fell off. If we were to conclude from this, that: "subsequently the small glands normally produce no digestive secretion," then such a conclusion is inadmissible, because the experiment created abnormal conditions which deviated substantially from those found in nature. Under natural conditions, the bodies to be digested reach the sessile glands enveloped in mucilage, and for various reasons, this mucilage may be a necessary prerequisite for the function of the glands. This is probable if only because the mucilage prevents the released digestive secretion from drying up. On the other hand, A. Meyer and Dewevre (1894) have not identified an enzyme in the mucilage of the stalked glands. Comparative physiology also leads me to share the view of Darwin (1876) and Goebel (1891). The sessile glands of *Dionaea* are morphologically equivalent to those of *Drosophyllum*, and these are certainly digestive glands[3].

Experiments concerning the functions of the stalked and sessile glands were performed after the appearance of the first edition of Fenner's (1904) book. However, he gave such an incomplete report of the results that one can not be certain just what his experiments prove. One the whole, Fenner (1904) shares the view of Darwin (1876) and Goebel (1891) that the stalked glands function primarily as traps, and the sessile glands as organs of digestion and absorption. He believes that the stalked glands influence the sessile glands positively, and stimulate their activity (1) by the secretion which they release, and (2) by the transmission of a chemical stimulus for which Fenner posits a system of special "conductor cells." Whether this is correct, the future must decide[4].

I shall now proceed to describe the histological structure of the stalked glands of the *Drosophyllum*. As Darwin (1876) noted, they are shaped like little mushrooms, and consist of a stalk and a slightly convex glandular disk. This consists of two cell layers, which compose the actual glandular tissue, under which follows the "intermediate layer"[5] (as Goebel [1891] used the term), which is supplied with cuticularized longitudinal walls. The stalk broadened at its upper end, is traversed by a vascular bundle that ends with an outspread group of thickened tracheids in a net-like pattern directly under the intermediate layer.

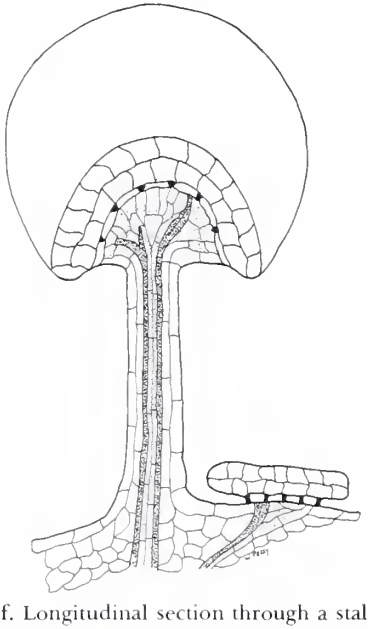


Fig. f. Longitudinal section through a stalked and sessile gland of *Drosophyllum lusitanicum*. The secretory cap is the double layer of cells just beneath the mucilage coat. Note the similarity of the cell layers with those of the *Drosera* tentacle in Fig. e. The vascular tissue has both xylem and phloem instead of having only xylem as in *Drosera*. The drawing is by Wayne Perry.

What interests us primarily is the structure of the epidermal glandular layer. As A. Meyer and Dewevre (1894) noted, this layer is covered by a relatively strong cuticle, in which however, these authors, "despite all efforts could not detect pores with certainty. When these glandular cells are killed, the red coloring material of the cell contents is quickly released and tinges the mucilage. This led A. Meyer and Dewevre (1899) to conclude that the cuticle is completely permeable, as the copious secretion of mucilage would suggest in any case. However, the porosity of the cuticle has not been established with certainty on glands with intact, or fixed protoplasts. The porosity can be very nicely observed[6] if one examines glands whose protoplasmic cell content was completely dissolved by treatment over several hours with Javelle water[7]. If one observes the surface with sufficiently strong magnification using an oil immersion objective one can see with great clarity and extremely fine and even performance of the entire cuticle covering the glandular tissue. On sections of the gland, one observes a fine crosswise striation of the cuticle (Plate VI, Fig. 12), so that there can be no doubt about the presence of very fine, extremely numerous pores in the cuticle (this was subsequently verified by Fenner, 1904, p. 415).

The epidermal glandular cells have approximately the same height and width. Viewing the surface, one sees rather thick wall ridges projecting into the cell lumen from the slightly thickened radial walls. These ridges widen out to merge smoothly with the outer walls (Fig. 13). At deeper focus the ridges become increasingly narrow, and soon disappear completely. On longitudinal sections through the gland, one sees that the wall ridges indeed disappear toward the bottom (Fig. 12); only a few extend down to the inner wall. The cell lumen then exhibits a number of shallow recesses on its upper edge corresponding to the number of ridges. The outer walls above these recesses are no thinner than usual.

The subepidermal glandular cell layer also has these ridges; however, there are many fewer of them.

The sessile glands exhibit the same structure as the stalked glands. The epidermal glandular cell layer likewise exhibits wall ridges on the radial walls (Fig. 14); these walls, as well as the ridges, are somewhat thicker than are those of the stalked glands. After treatment with Javelle water[7], the rather strong cuticle appears even more finely perforated than it does in the case of the large glands; I would hardly venture to interpret these extremely fine, evenly distributed perforations as an indication of the porosity of the cuticle, if the comparison with the undoubtedly porous cuticle of the stalked glands did not argue in favor of it.

If we now relate the structural characteristics we have described to the various functions of both glandular forms, it is clear, first of all, that the porosity of the cuticle facilitates and accelerates both secretion and absorption. It is also reasonable that the cuticle of the large mucilage-secreting glands is more clearly porous than that of the small glands. The even distribution of the fine pores over the entire surface of the exterior walls further argues that secretion and absorption are not localized on particular parts (e.g, those parts bordered by the wall ridges) of the outer walls.

What is the function of the ridges of the radial walls? A mechanical function, similar to that present in delicate petals, is hardly likely since the majority of the ridges do not extend down to the inner walls. It is more probable that the formation of ridges was intended to enlarge the surface area of the plasma membrane, a development which would assist in the absorption of dissolved materials and in the perception of chemical stimuli.

Drosera rotundifolia. The tentacles of this plant, so often described, have, as Goebel (1891) previously emphasized, essentially the same structure as those of *Drosophyllum*. The club-shaped end of the vascular strand which traverses the stalk is surrounded by the cuticularized "inter-

mediate layer"[5], and this in turn, by the glandular tissue, which is mostly double-layered. The outer layer of the glandular tissue of the secretory cap has long, palisade-shaped cells on the top, which gradually become shorter on the sides. In the case of the peripheral tentacles, of course, the oblong secretory cap is shifted to the upper side of the broadened end of the stalk (Fig. e).

Contrary to the statements of Goebel (1891) and Gardiner (1885), Lily Huie (1897) has already established the existence of a cuticle on the secretory cap. I can only confirm her findings; upon treatment with sulfuric acid, the cellulose walls of the glandular tissue are quickly destroyed, and the cuticle stands out like a blister against the swollen cap. This cuticle is relatively well-developed, although it is not as thick as that of *Drosophyllum*. Both of these share the same high degree of permeability. The permeability of the cuticle is easily demonstrated by cutting off a tentacle and its stalk from a leaf that has been fixed in alcohol, and placing it in zinc chloride-iodine solution[8]. The cuticle quickly turns yellowish-brown. Immediately thereafter, the bluing of the cellulose walls of the glandular tissue also begins, and the dark blue cap stands out strikingly from the yellow-brown stalk, whose cellulose walls remain colorless because of the impermeability of their cuticle. The bluing proceeds slowly only from the cut end, just as it also disperses gradually downward from the cap to the stalk. The papillae located on the stem turn grayish-blue, indicating that their cuticle is likewise permeable. I have observed no difference in the time required for the coloration of the elongated apical glandular cells, and the lower, lateral glandular cells; therefore, all parts of the cap seem to be equally permeable.

Lily Huie (1897) tried in vain to observe the tiny pores on the cuticle of the secretory cap with a microscope. I have not been successful in this either, despite the use of apochromatic objectives. Nevertheless, I do not doubt, in view of the directly observable porosity of the cuticle in the case of *Drosophyllum*, that the cuticle of the secretory cap of the *Drosera* is also penetrated by very fine pores[9].

If the cap of a parietal tentacle is clarified with Javelle water[7], one can immediately observe, with sufficiently strong magnification, a noteworthy structural peculiarity of the epidermal glandular cells. To my knowledge, this feature has remained either unnoticed, or was only vaguely mentioned, and has therefore been partly misunderstood. Viewing the surface, one immediately recognizes the same ridges present in *Drosophyllum*. These ridges extend outward from the radial walls. Here of course, they are more delicate, smaller, and also do not extend downward nearly so far as in the *Drosophyllum*; however, they do occur in greater numbers (12-15 in one cell) (Plate VI, Fig. 18). The small recesses they form are elongated to short pit canals, which project in a somewhat more slanting direction into the outer walls of the glandular cells. These pit canals are filled with little papilla-like appendages of protoplast. One can easily make these visible by soaking them for a short period in dilute sulfuric acid, and then crushing the secretory cap by pressing on the cover glass. Now the individual protoplasts of the glandular tissue emerge from the swollen cell walls fixed, and can easily be observed in different positions (Plate VI, Fig. 15 a, b, and 16). If, in addition, these are stained with toluidine blue one obtains, after successive rinsings, very beautiful and instructive slides. One can now see that protoplasts of the lateral epidermal glandular cells are supplied with a ring of tiny plasmatic papillae on the corners of their outer sides, which have a thickness of 1.5-2 μm and are approximately of equal height[10]. The protoplasts of the apical palisade-shaped glandular cells exhibit fewer papillae, ordinarily only on the corners of the cells. Thus in the side view, an isolated protoplast shows only two papillae on the upper corners (Fig. 17).

The surface glandular cells of the peripheral tentacles have the same structure. The cells situated on the edge of the glandular body correspond to the lateral cells of the secretory cap located on the surface, and have ridges, or plasma appendages similar to these. The centrally located cells, on the other hand, usually exhibit points, or plasma appendages only in the corners of the outer walls.

In the case of *Drosera longifolia*, the peripheral points, or plasma appendages which protrude from them are still more clearly differentiated than in *Drosera rotundifolia*. Here they are often twice, or even three times as high as wide (Plate VI, Fig. 19). The protoplasts of the apical glandular cells, which are isolated by treatment with dilute sulfuric acid and stained with toluidine blue, sometimes have a peculiar appearance: on the squat, conical upper part of the protoplast sits a cluster of 3-5 thin plasma appendages (Fig. 20). The apparent explanation for this seems to be that as the lateral walls slope inward and reduce the outer cell wall, they draw the appendages on the corners into a cluster in the center of the cell.

The apical glandular cells of *Drosera dichotoma* are somewhat different. The wall ridges are more numerous here, penetrating further toward the middle of the outer walls, and often merging with one another so that in places, they create a net whose interstices are usually elongated, and are filled with correspondingly shaped plasma appendages (Plate VI, Fig. 22). One might also mention the wide pits which occur in the outer walls. Just as in the case of *Drosera rotundifolia*, the lateral glandular cells of the cap usually only have pits on the edges of the outer walls (Fig. 21).

The structural relationships of the glandular cells of the *Drosera tentacles*, here described in detail, had already been observed by Goebel (1891) and Gardiner (1886), but they only mentioned them in passing. Goebel (1891) limited himself to the remark that the outer cell walls are pitted. In the case of *Drosera dichotoma*, Gardiner (1886) calls these "remarkably pitted." Illustrations were not given by either of the researchers. On the other hand, Lily Huie (1897) discussed these structural relationships in greater detail, but oddly enough, she misunderstood them completely. On microtome sections she had indeed seen the wall ridges, which extend from the radial walls of the lateral glandular cells into the outer walls, and she illustrates these correctly. However, she considered them to be "toothlike" projections of the outer walls, and concluded that wide and deep pits were present but in this she was deceived. Had Huie not simply limited herself to the observation of 5μm thick microtome sections, but also used preparation methods which would have enabled her to visualize the subject in three dimensions, she would have noticed that the upper edge of each protoplast bears a ring of plasmatic papillae projecting into hollow cavities which are probably none other than pit chambers.[11].

What is the function of these curious plasma appendages in the outer walls of the glandular cells? In the case of *Drosera dichotoma*, Gardiner (1886) considers the pits in which they are found to be the points from which mucilage is secreted subsequent to stimulation: but since in the case of *Drosophyllum*, the cuticle is covered with fine pores over its whole surface, and not just over the recesses, and since the cuticle of *Drosera* is very likely permeable to the same degree everywhere, I do not believe that the existence of pits in the outer walls is related to the mucilage secretion. For the same reasons, they probably also have nothing to do with the intake of substances, as Goebel presumes. Otherwise, one would also expect to find them on the outer walls of the digestive glands and absorption hairs of other insectivores. Since this is not the case, it is a well-justified assumption that the presence of pits and plasma appendages in the outer walls of the secretory cap of the *Drosera* species is connected with the high degree of sensitivity of these glands to

chemical and mechanical stimulation. And it is particularly the latter type of sensitivity which seems to offer the best explanation for their existence. Further evidence for this is offered by the case of *Drosophyllum*, whose tentacles do not respond to mechanical stimulation. Here, the recesses between the wall ridges are not elongated to form pit chambers, and plasma appendages are not present[12]. I therefore consider the plasmatic papillae of the glandular cells of *Drosera* to be primarily organs of perception for mechanical stimulation. By this I do not mean to say that they do not possibly also serve for perception of chemical stimuli, and so represent tiny gustatory organs, as it were. After all, in the case of various lower animals, the same sensory organs seem to function for both touch and taste.

This conviction was strengthened by Pfeffer's (1884) investigations, which showed that tendrils exhibit the same type of mechanical sensitivity as the*Drosera* caps. Sometimes tactile pits with sensitive plasma appendages occur (Cucurbitaceae). They are, of course, distributed differently. In contrast, the plasmatic papillae of the apical glandular cells or *Drosera* are very similar to the plasma appendages of the sensory cells of the barberry anther. And this includes the manner in which they occur—namely, in the corners of the cell.

REFERENCES

Ch. Darwin. 1876. Insektenfressende Pflanzen. trans. V. Carus (Stuttgart).

C. A. Fenner. 1904. Beträge zur Kenntnis der Anatomie, Entwicklungseschichte und Biologie der Labblätter und Drüsen einiger Insektivorne. Flora. 93: 335-434.

W. Gardiner. 1896. On the Phenomena accompanying stimulation of the gland cells in the tentacles of *Drosera dichotoma*. Proceedings of the Royal Society of London 39:229-234.

K. Goebel. 1891. Pflanzenbiologische Schilderungen (Marburg).

Lily Huie. 1897. Changes in the cell-organs of *Drosera rotundifolia*, proceeded by feeding with egg-albumin. Q. Journ. Mic. Sci. 39: 387-425.

A. Meyer and A. Dewevre. 1894. Über *Drosophyllum lusitanicum*. Bot. Centralblatt 60: p. 23.

W. Pfeffer. 1884. Zur Kenntnis der Kontraktreize. Untersuchungen aus dem bot. Institut. zu Tübingen. 1: pp. 512-513.

O. Rosenberg. 1899. Physiologisch-cytologische Untersuchungen uber *Drosera rotundifolia* L. (Upsala).

ENDNOTES

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1. Darwin (1875, *Insectivorous Plants*) demonstrated that tentacles with their glands removed do not respond to stimulation when mechanical stimuli are applied directly to the stalk and that hard objects thrust into the mucilage will not cause movement unless they touch the head of the tentacle (see fig. e). However tentacles would also have the uppermost cells of the stalk removed or damaged. It is these cells in the uppermost part of the stalk which are deformed most when the gland is pushed with a probe and it is these cells which are homologous with the sensory cells of *Dionaea*. Elsewhere I have proposed that they are the sensory cells (Williams, 1976, Am. Philos. Soc. 120, 187-204). Firm evidence favoring a sensory role for the gland cells or for the stalk cells is lacking and the question must be left for future experiments to resolve.

2. Many of Darwin's "nitrogenous substances" such as meat, and egg-white would have contained sodium salts which Darwin himself demonstrated to be highly stimulitory to *Drosera* tentacles. The results of ex-

periments with such poorly defined stimuli must be considered ambiguous. Meat stimulates tentacle movement but it is unclear whether it is because of nitrogenous substances it contains or because it contains sodium salts.

3. See also Fenner (1904) and Williams (1976, Amer. Philos. Soc. 120, 187-204) for a comparison of the glands of these plants. Recent work in Juniper's laboratory has greatly expanded our understanding of both the digestive glands of *Dionaea* (Robins and Juniper, 1980, New Phytol. 86, 279-327) and the sessile glands of *Drosophyllum* (Joel and Juniper, see Williams, C.P.N. *10*, 36).
4. Quintanilha (1927, Biol. Soc. Brot. 4:44-129) has done further work on this subject which is published in Portugese with a French resume. Lloyd reviews some of this paper in *Carnivorous Plants.* Quintanilha found that stimulation of the stalked glands with albumin will result in secretion by the sessile glands and he proposes that a signal must pass from the stalked glands to the sessile glands by a pathway that is still not clear. He reports that direct mechanical stimulation of sessile glands will stimulate secretion but that mechanical stimulation of stalked glands, except in the extreme case of their removal, will not result in secretion of the sessile glands. Franca (1922, 1925) also did important work on this topic which was reviewed by Lloyd.
5. This is an endodermis common in many plant secretory structures (c.f. Lüttage and Higinbothan, 1979, *Transport in Plants* pp. 90-92, Springer-Verlag).
6. Schnepf (1965, Ber. dtsch. bot. Ges. 78, 478-483) has published electron micrographs illustration pores which are 0.2 to 0.3 µm across. These pores which are somewhat larger than those of *Drosera* are near the limit of resolution of the light microscope. Haberlandt did well to observe them.
7. Javelle water is a solution of chlorinated potash. When freshly prepared, it contains about 2.5% active chlorine. *The Merck Index*, 8th Ed., Rahway, New Jersey (1968).
8. Zinc chloride iodine solution was a test for various polysaccarides which could be identified by the color they develop when treated with this solution.
9. *Drosera* has been demonstrated to have pores which are just below the limit of resolution of the light microscope. Ragetli et al. 1972, Can. J. Bot. 50, 159-168; Chafe and Wardrop, 1973, Planta 109, 39-48; Williams and Pickard 1974, Planta 116, 1-16).
10. These "papillae" are the cytoplasm that fills the spaces between the cell wall ridges Haberlandt describes. When hardened with a fixative and isolated from their walls they have the appearance illustrated (figs. 16, 17, 19, 20). This observation does not by any means prove they are sensory receptors.
11. The function of these ridges in the cell wall is unclear but it seems unlikely that they have a role in anything more than giving strength to the gland or increasingly the membrane surface area.
12. The lack of "pit chambers" in *Drosophyllum* is neither a necessary nor a sufficient condition for their acting as sensory structures in *Drosera*.

Nepenthes *(Continued from page 64.)*

regular fertilizing has only just begun.

Brought into cultivation to England in the early 1900s and subsequently lost, this, the most dangerous looking *Nepenthes,* re-enters cultivation again. With luck it may be common in collections in the not-too-distant future.

I would like very much to thank Ron Zillins for the time and effort put into the excellent close-up photographs which have done this unique species justice.

(Continued on page 78.)

A Field Trip to Singapore

by M. Woodring, 860 Shone Dr., Reno, Nevada 89512

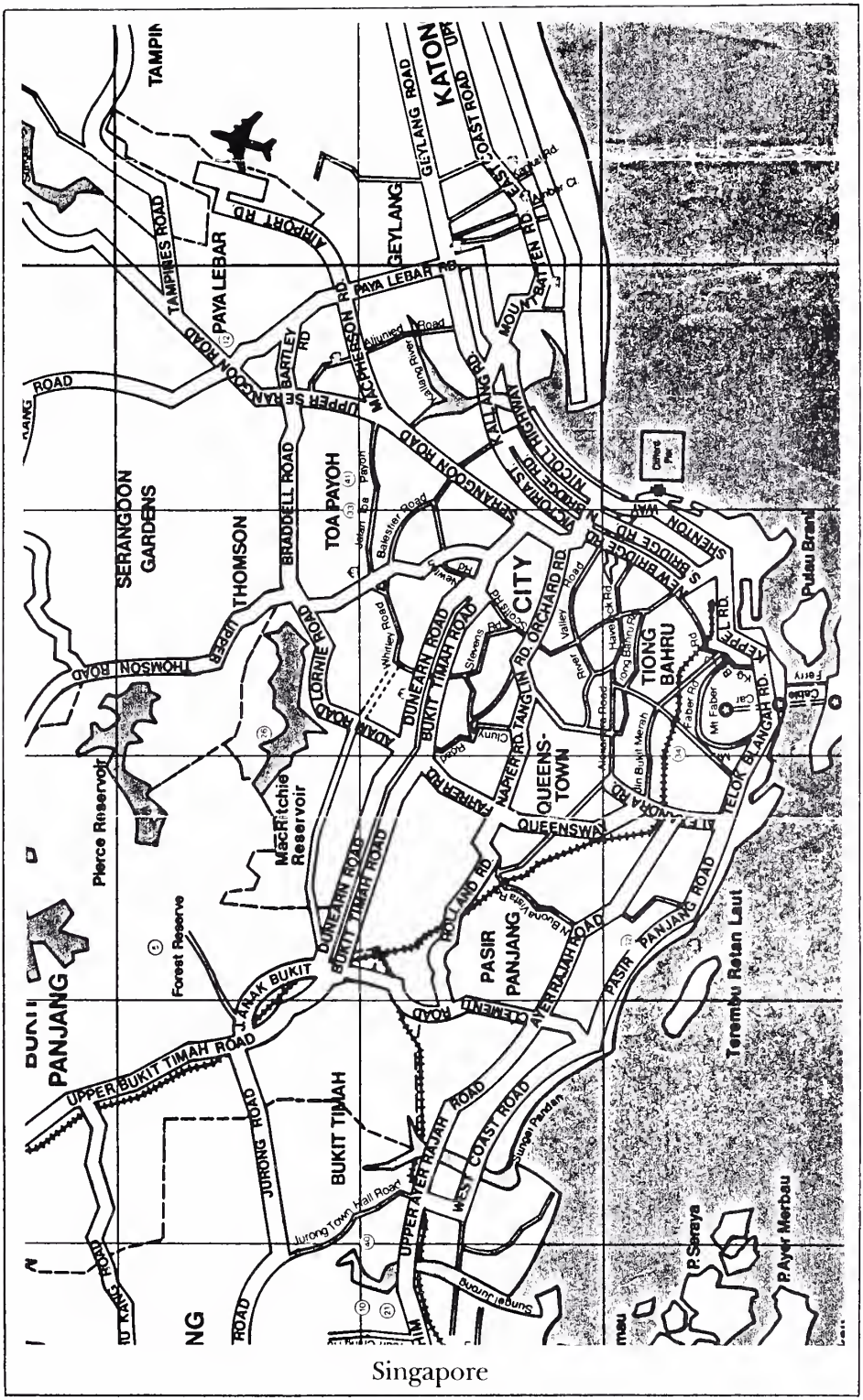
I arrived in Singapore on business to find all my equipment had been held up in customs. With little to do without it—but wait!—I quickly consoled myself by setting out to search for *Nepenthes*. Singapore has very a extensive bus network as I soon found by buying a "SBS GUIDE" (Singapore Bus System) for 70 cents Singapore. Taxis are also far more abundant than in the States so getting around didn't seem to be a problem. The locals were very courteous and since most business was conducted in English, they spoke far more English than I did Mandarin. "What could be easier?" I thought. Well, after three days of hitting all the local gardens, a dozen nurseries, and asking everyone that would listen, several easier tasks came to mind. On the fourth day, tired and depressed, I mentioned my plight to Lim Soon Leng, an Aeronautical Engineer with whom I was working in Singapore, who thought that the Singapore Tourist Promotion Board might be able to help me.

I went to the Singapore Tourist Promotion Board for help in finding *Nepenthes* or "monkey's cup" as the locals called them and was referred to a local botanist, Thomas J. Maxwell, at the Singapore Botanical Gardens. Mr. Maxwell gave me directions to the three areas known to have *Nepenthes*; (1) Bukit Timah Nature Reserve for *N. gracillis, N. ampullaria,* and *N. rafflesiana*. (2) South Buona Vista Road for *N. gracillis* and *N. ampullaria*. (3) Mac Ritchie Reservoir for *N. gracillis*. Mr. Maxwell was very kind to invite me along on an expedition to Bukit Timah Reserve he had organized for several others looking to collect specimens of various plants, fungii, and insects for their studies.

We all gathered at the entrance to the Reserve the following morning. The path into the Reserve was a very steep climb of about 45 degrees. Before going 100 meters the first of our group found something and was off the path and on her own. It required several stops to catch our breaths and to recover from the high humidity before we reached the first fork in the road. As we penetrated deeper into the jungle we broke into small groups and gradually went off into different directions with each group looking for its own "treasure."

Maxwell gave me rough directions and I was off through the jungle trails searching for any sign of *Nepenthes*. As I followed the trail I came to the edge of a cliff created by a large rock quarry that was the boundary of the Reserve. The upper edge of the cliff was covered with ferns about one meter high, clear of the large trees and in full sun. The vines of *N. gracillis* could be seen everywhere among the ferns. As I made my way off the trail through the dense vegetation I came upon a large *N. rafflesiana* one full meter high. It was a wonderful sight and to think I almost walked past it! Such a large carnivore is hard to imagine but to find that it was only a small part of a much larger plant was truly inspiring. The plant grew from the middle of a 1 cm black vine that came from under the dense ferns, lay along the ground for three meters and then went up into a tree at least ten meters high and vanished into the upper foliage! The vine could not be moved as it was firmly rooted to the ground along the entire distance. In the entire Reserve, this was the only *N. rafflesiana* that I could find. The ground was a very hard and nonporous clay with only a few centimeters of decaying humus covering the surface.

As I pushed through the ferns looking for *N. ampullaria*, the vines of *N. gracillis* could be seen everywhere. It was impossible not to damage the vines as we moved about since they were laced throughout the ferns and other foliage and took every opportunity to grow up to the sunlight.


TAMPIN
KATON
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AIRPORT RD
PAYA LEBAR
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TAMPINES ROAD
MOUNTBATTEN RD
MACPHERSON RD
UPPER SERANGOON ROAD
BARTLEY RD
SERANGOON ROAD
SERANGOON GARDENS
THOMSON
THOMSON ROAD
UPPER THOMSON ROAD
BRADDELL ROAD
TOA PAYOH
Jalan Toa Payoh
Balestier Road
Whitley Road
LORNIE ROAD
ADAM ROAD
DUNEARN ROAD
BUKIT TIMAH ROAD
County Road
Stevens Rd
Coastal Rd
Newton Rd
CITY
ORCHARD RD
TANGLIN RD
MARKET RD
FARRER RD
QUEENS-TOWN
QUEENSWAY
Alexandra Road
Jln Bukit Merah
Hawkick Rd
Tong Eng Rd
Valley Road
River Valley Rd
TIONG BAHRU
Mt Faber
Faber Rd
TELOK BLANGAH RD
HEPPEL RD
NEW BRIDGE RD
S BRIDGE RD
SHENTON WAY
VICTORIA ST
NICOLL HIGHWAY
CHANGI RD
Changi Road
Pulau Brani
Ferry
Pierce Reservoir
MacRitchie Reservoir
Forest Reserve
BUKIT PANJANG
UPPER BUKIT TIMAH ROAD
JANAK BUKIT
JURONG ROAD
BUKIT TIMAH
Jurong Town Hall Road
UPPER AYER RAJAH ROAD
WEST COAST ROAD
Sungei Jurong
Sungei Pandan
PASIR PANJANG
POLLAND RD
CLEMENTI ROAD
AYER RAJAH ROAD
PASIR PANJANG ROAD
Sungei Bukit Timah
Terembu Retan Laut
P. Seraya
P. Ayer Merbau

Singapore

It was not very long before Maxwell had spotted a *Nepenthes* vine much thicker than that of *N. gracillis* among the ferns. We pushed back the ferns to discover a small cluster of *N. ampullaria* pitchers around the vine where it lay along the ground. We followed the vine back under the ferns where it lay almost completely covered by 10 cm of dead fern leaves. We exposed 1.5 meters of *N. ampullaria* vine and two more clusters of pitchers. One cluster was over 60 centimeters across. As with the *N. rafflesiana* we could not find the base of the vine. The pitchers formed clusters along the vine as it lay on the ground and were half covered by the falling debris from the ferns. The vine turned up through the ferns where the leaves could reach the sunlight. There were no pitchers on the leaves of the plant as there was with *N. rafflesiana* or *N. gracillis.* Examination of the pitchers showed them to be almost full with captured ants.

As we uncovered more clusters of *N. ampullaria*, the excitement spread to others of the group. They rushed over to examine the find and to take photographs. One fellow forgot that we were on the edge of a 100 meter cliff concealed by the dense shrub and stepped into a small crevice leading over the cliff! His fall was stopped as his outstretched arms became entangled in the vines as he went down. You could say his life was saved by a carnivorous plant! With him saved and a bit more cautious celebrating, Maxwell asked if the liquid in the pitchers could be drunk. Considering the oppressive heat and humidity it didn't seem to be a bad idea. However, I suggested that the liquid from the unopened pitchers would be much more palatable. Maxwell was the first to drink and noted that there was not much fluid to drink and that it didn't do much to quench his thirst. The low level could have been due to a dry spell Singapore had suffered for the past two months. We thought it would taste like distilled water but it didn't. It had a slight flavor that could have been due to digestive enzymes already present in the liquid.

Next, I went to the area of South Buona Vista Road that Mr. Maxwell had suggested. After catching a bus and explaining to the driver where I wished to stop, I enjoyed the scenery for about 20 minutes when someone tapped me on the shoulder and literally pushed me out! When the bus pulled away, I saw the sign for South Buona Vista Road and realized that someone had actually done me a favor. Without any delay, I started up the rural road in search of *N. ampullaria* and *N. gracillis*. The road twisted tightly up and around a hill and about 500 meters later it was quite steep on both sides of the road and covered with dense vegetation. The hillside had been stripped of all large trees several years ago in anticipation of new construction in the area but was postponed according to Mr. Maxwell and that allowed the dense undergrowth to reclaim the area more vigorously. The only remaining trees bordered the road. It was in this area that the first *Nepenthes* were found.

The first plants discovered were *N. gracillis*. They were growing on the uphill side of the road's embankment in partial shade. The soil was the same as it was at Bukit Timah, hard clay with a thin covering of humus. One cluster of vines was over a foot in diameter comprised of dozens of individual plants growing up into a tree. Most of the vines were old and dried but the younger ones (less than three meters long) had pitchers on a majority of their leaves. Several more of these large groups of *N. gracillis* vines could be found throughout the trees. It seemed that once a vine had established a path up into a tree others followed. Was it to provide an alternative route for the ants that seemed to be making their way up every tree and thus capture a good percentage of them for the plants benefit? Or, were the plants merely attempting to reach a more plentiful supply of sunlight? I was amazed at the number of variations in the pitchers in this small area. Some were entirely green, others were dark crimson, still others were half and half. Some resembled *N.*

Cluster of ground pitchers of *N. ampullaria.*
Photo by M. Woodring

alata and others resembled *N. thorelii*. The largest pitchers were 15 cm and the vines were impossible to measure but I would guess they were over 10 meters long. Was I looking at more than one pitcher, I discovered a small red crab-shaped spider apparently unaffected by the fluid and able to move about without any difficulty on the sides of the pitcher. It did not appear to be trapped and there was no evidence of any other insects trapped by the plant within the pitcher. Had the pitcher failed to capture any insects, or did the spider remove those that the plant had caught?

Soon I came upon *N. ampullaria* in a very shaded location in a crevice eroded by water. There were a lot of dead leaves trapped by the plants as they were washed down the crevice. The pitchers were comprised of small clusters sprouting from the main vine at the base of an old leaf. Each cluster may or may not have leaves apparently depending on whether or not that cluster was buried under the debris or in contact with the sunlight. I could find only this one *N. ampullaria*. It was much smaller than the sprawling vines at the Reserve and had a deep green color rather than a speckled yellow-green.

Finally, I went to MacRitchie Reservoir. It was one of the main supplies of fresh water for Singapore. After searching for some time around the perimeter of the Reservoir and in throughout the bush, I started back toward the entrance without any luck. Following one of the footpaths used by local joggers, I noticed a *Nepenthes* vine entangled in a bush down a steep embankment right next to the water's edge. It was impossible to reach the plants without falling into the water below. Perhaps that is why the plants were unmolested. Again, there seemed to be more than one species here. This time however, I noticed the leaves were also slightly different. The plant that more strongly resembled *N. gracillis* had thinner and more fragile leaves; the other had much more robust ones. The largest of the *N. gracillis* pitchers were found here: 15 cm for living traps and approximately 18 cm for dried traps found on the plants. This also was the only *Nepenthes* found in flower. Both male and female flowers were visible at one time. I was unable to get any closer and gather samples of the flowers or pitchers.

(Continued from page 73.)
Those interested in obtaining slides or enlargements of this and other species of CP should contact:

High Key Photo, 914 Woodmere Cir., Ormond Beach, Florida 32074

Bibliography

1. S. Kurata, *Nepenthes of Mount Kinabalu,* Sabah National Parks Publication No. 2, Sabah National Parks Trustees, (1976) pp. 37-40.

2. Danser, B. H., *The Nepentheacae of the Netherlands Indies,* Bull. Jard. Bot. Buitenz., Ser. III. Vol. IX, Liv. 3-4, (1928) pp. 405, 407.

3. Danser, pp. 270-272.

Carnivorous Plant Seed

In your recent issue of December 1981, in the article on the Fernkloof Nature Reserve, written by Mr. Alain Christophe, it is mentioned that I am a possible supplier of *Drosera* seeds.

This position is as follows: I have a seed catalog which lists shrub and tree species but does not contain any insectivorous species. This list will be of little or no interest to your members.

When Mr. Christophe visited me, we discussed the possibility of my supplying this seed, but I had no way of judging the likely demand. As a result of the article, I have now received letters from many parts of the world asking for *Drosera* seed.

Could you perhaps advise your readers that I now intend to collect *Drosera* seed and will communicate eventually with all who have written to me, advising prices and species available.

In the meantime, your members may care to write to the following address to obtain a catalog of 18 species of insectivorous plant seeds, cacti, etc.

Exoticana Seeds
P.O. Box 184
Greytwon 3500
SOUTH AFRICA

I look forward to further correspondence with you and ask your members who have written to be patient.

ss/Y. Woodvine

N & V *(Continued from page 56.)*
Borneo but so far I have not been able to substantiate this. I would be interested in hearing from anyone who has come across the winged-tendril form in the *Nepenthes* genus.

ADRIAN WALTER (4 Homer Road, Clarence Park, South Australia 5034) writes: Recently in South Australia we formed a carnivorous plant society which has gotten off to a roaring start. Within six months of our first meeting we have some eighty members.

I have enclosed for your interest a copy of our first newsletter which at the moment we hope to produce on a quarterly basis.

Starting with the next issue we will be including the first of a series of fifteen articles on South Australian carnivorous plants. These are kindly being written by Ray Nash, a man who has done a lot of research on these plants (and other Australian CP) over the past ten years or so.

We would appreciate it very much if you could mention our society in your newsletter. We can guarantee with our current membership and the amount of enthusiasm we all have for CPs, that our society is here to stay.

WANT AD

Bruce Bednar, 25 Lake Court Loop, Ocala, FL 32672. (WBT) *Heliamphora,* especially *minor.* (T) *Nepenthes madagascarensis,* × *minamiensis,* × *accentual Koto,* × *fukaksiana,* × *Ville de Roven,* × *sens,* × *wittei,* 60 more.

Review of Recent Literature

Conn, B. J. *The Drosera peltata Drosera auriculata* complex. J. Adelaide Bot. Gard. 3 (1): 91-100, 1981.

D. peltata and *D. auriculata* are variable taxa which consistently intergrade in parts of their range. The author reduces *D. auriculata* to a subspecies of *D. peltata* (*D. peltata* ssp. *auriculata* stat. nov.)

Folkerts, G. W. 1982. The gulf coast pitcher plant bogs. American Scientist 70: 260-267 (May-June), also cover photo.

This is a well written popular article for the knowledgeable reader, dealing mainly with Sarracenias of the gulf coast areas. There are excellent color photos and nice summary discussions of carnivory and its value, theories of possible prey partitioning, insect associates, and the ecology and future of pitcher plant bogs. Very worthwhile. DES

Hilton, D. F. J. 1982. The biology of *Endothenia daeckeana* (Lepidoptera: Olethrutidae), and inhabitant of the ovaries of the northern pitcher plant, *Sarracenia p. purpurea* (Sarraceniaceae). Can. Ent. 114: 269-274.

The life cycle of this lepidopteran in the flowers of *S. purpurea* ssp. *purpurea* in a bog in Quebec is described along with laboratory rearing studies. The larvae consume ovules in the ovary, and immature instars over winter in scapes. The lepidopteran larvae are themselves prey to several Ichneumons. A fungus often encases unconsumed seed in mature capsules. A well done, detailed and interesting study. DES

Kirchner, B., *Pinguicula esseriana* (Lentibularlaceae)—a new species from Mexico. Willdenowia 11 (2): 317-319 (1981).

A new species of *Pinguicula* with triangular succulent-type leaves was found in San Luis Potosi. The flower's corolla is pale violet and has a spur of medium length and is placed in the section Orcheosanthus. The plant was named after Professor Karl Esser, a director of the Botanical Garden in Bochum, Germany.

Love, A. (Ed.) 1982. IOPB Chromosome number reports LXXV. Taxon 31:344, 355. This is a regular feature of the journal Taxon in which several pages of chromosome numbers recently reported from several genera and species are listed. The following CP are reported this issue (see journal for names and addresses of chromosome analysts):

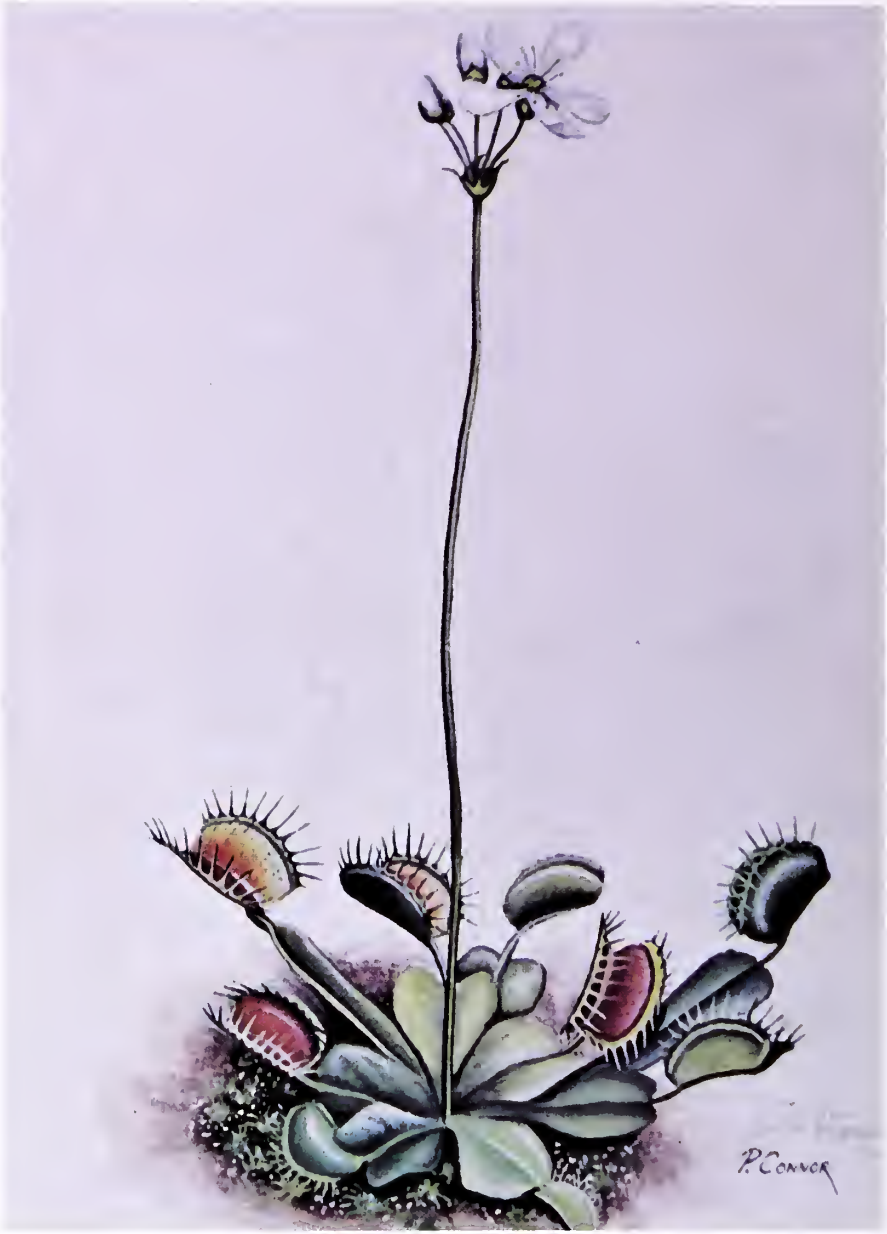
Sarracenia purpurea 2n=26, *Drosera anglica* 2n=40, *D. linearis* 2n=20, *D. rotundifolia* 2n=20 (These are from several pages of all kinds of genera and species from a survey of flora of Manitoba, Canada); *Pinguicula villosa* 2n=16, *P. vulgaris* 2n=64, *Utricularia intermedia* 2n=44, *U. minor* 2n=44, *U. vulgaris* 2n=44. DES

Mody, N. V., Henson, R., Hedin, P. A., Korpol, U., and Miles, D. H. Isolation of the insect paralyzing agent Coniine from *Sarracenia flava*. Experientia 32: 829-830. 1976.

The authors chopped up about 45 kg of *Sarracenia flava* leaves and isolated from them a drug with the structure consistent with the chemical formula of coniine (2-n-propylpiperidine). This substance was shown to paralyze fire ants in 30 seconds when exposed to 100 ng of the drug. This discovery may indicate the principle mechanism of how insects fall into tall pitchers after ingesting the nectar secretions on the lip of the pitcher.

Wheeler, G. A. and P. H. Glaser. 1982. Vascular plants of the Red Lake peatland, Northern Minnesota. Mich. Botanist 21: 89-93.

This is the latest of several lists from this recently popular floristic area. Among all the plants, the following CP appear: *Drosera anglica, D. intermedia, D. linearis, D. rotundifolia, Utricularia cornuta, U. intermedia, U. minor, U. vulgaris,* and *Sarracenia purpurea.* In addition to being a species list, there is a brief notation about habitat for each.



Dionaea muscipula (Venus' Flytrap).
Painting by Paul Connor