What's In a Name?

THE BOSS AND THE CODE

by Kit Knotts

How are cultivated plants named, and who is the amazing man who is boss of that process? Before answering these questions, we need to wade through a few items.

The Acronyms

IWGS – International Waterlily and Water Gardening Society

CWGS – Colorado Water Garden Society

ISHS – International Society for Horticultural Science

ICRA – International Cultivar Registration Authority (ISHS governs these and IWGS is ICRA for *Nymphaeaceae* and *Nelumbo*)

ICNCP – International Code of Nomenclature for Cultivated Plants (for cultivars)

ICBN – International Code of Botanical Nomenclature (for species)

DBG – Denver Botanic Gardens

RHS – Royal Horticultural Society, based in England

The Players

Piers Trehane – Chairman of the ISHS Commission for Registration and Nomenclature, chief editor of the current ICNCP

Andrew Doran – DBG Taxonomist and IWGS Registrar for *Nymnphaeaceae*

Virginia Hayes – IWGS Registrar for *Nelumbo*

Piers Trehane displays RHS color charts to the group with Andrew Doran looking on

Cyndie Thomas – President of CWGS

Nancy Styler – Co-Administrator of the IWGS Victoria Conservancy and CWGS Publicist

Trey Styler – Co-Administrator of the IWGS Victoria Conservancy and member of the IWGS Board of Directors

Joe Tomocik – DBG Aquatic Manager

Stan Skinger – Propagator of tropical waterlilies at DBG, CWGS Vice-president

Walter Pagels – IWGS Librarian, Historian, Board Member and legendary collector

Mary Mirgon – with husband John and Joe Tomocik, founders of CWGS, the first waterlily society

Andy Lohaza – Canadian water gardener, specializing with William Phillips in culture of Australian waterlilies

Kit Knotts – former IWGS Registrar and hybridizer of *Victoria* and *Nymphaea*

Piers Trehane at Denver Botanic Gardens, April 2001.

Mini-Glossary

Nomenclature – the way plants are named in an understandable, international system

Taxonomy – the way plants are classified into related botanical groups

Nymphaea – waterlilies

Nymphaeaceae – the bigger waterlily family which includes the genus *Victoria* and several others

Nelumbo – lotus, which used to be part of *Nymphaeaceae* but now given its own family by taxonomists

Taxon – the nickname for a taxonomic group

Cultivar – (from the glossary of the Code) a taxon of cultivated plants that is clearly distinct, uniform, and stable in its characteristics and which, when propagated by appropriate means, retains those characteristics.

If you don't think it would be fun to be in the same room at the same time with all the above people, initials, and potential subjects for discussion, stop reading now. The weekend of April 7-8, 2001, it happened.

CWGS seized the possibility that Piers Trehane might be available to travel from England to Denver to be the keynote speaker at their annual "Ponds…Links to Learning" seminar. The invitation was made, accepted and a special session was offered with Piers for those especially interested in the naming and registration of waterlilies. We convened at DBG and Piers spoke.

"In the 1700's, during the period known as the Age of Enlightenment," began Piers Trehane, "the cultural revolution in Europe included natural history. The interest in plants was widespread, and a young man named Carl began the study of the flora of his native Sweden. Since surnames didn't really exist at the time, this man gave himself the last name of Linnaeus, after the linden trees near his home."

Linnaeus, it seems, was an arrogant, naughty, saucy young man who, as he flitted around Northern Europe, collected as many ladies as he did plants and plant names. Nevertheless, his system of naming plants, developed somewhat by accident, is that used almost universally today. During that time, the convention was to use descriptive phrases in Latin for genus and species plant names. As more and more plants were discovered, the names grew longer and longer. In 1753, Linnaeus published his *Species Plantarium*, the title another testament to his

Piers Trehane, Virginia Hayes, Walter Pagels, Teresa Westhoven, and Andy Lohaza behind them

Nymphaea mexicana 'Cape Canaveral' Frase 1958

arrogance, since it literally means all the species on the planet.

In order to work effectively with the printer of *Species Plantarium*, Linnaeus jotted "trivial names" (inconsequential – not real scientific names at all but just handy tools) in the margins of his manuscript, which made their way into the printed form of the book. It is this "trivial name" concept that denotes Linnaean nomenclature used by the botanical and zoological community ever since. It is also called binomial nomenclature since it is limited to two words and not more. Though efficient, it divorces the names of plants from the science of taxonomy and gives Piers and his associates job security forever.

"We name plants for the purpose of communication," Piers continued. "The discipline of nomenclature became a pursuit of its own, not a science though the scientists had to learn and use it. Every few years the scientific community gathers to discuss and update rules."

The "Bible" for naming wild plants is the ICBN. It addresses both rules of naming and tries to unravel the confusion in nomenclature created by the wars, distances, and bad communication of the past. For many years, the same system was used for manmade plants. In the 1950's, a new Commission was assigned the task of developing the first ICNCP, currently in its sixth edition with another due in 2003. Until the 1995 Code was published, even the Preamble was incomprehensible to most lay people. Piers, as Chief Editor of the 1995 Code, made it a handbook that all can understand and use.

"As human beings, we sort things into groups every day. They are things that are enough alike to have the same name. We sort flatware into knives, forks, and spoons. Those are taxonomic groups. Taxonomy sorts into groups and nomenclature gives the groups names." Piers then discussed the elements of the Code in detail.

Within waterlilies, as in all other groups, we can't duplicate names or it will cause great confusion. The names of wild plants are expressed in Latin form and must also be described in Latin, or the names cannot even be considered as valid. Fortunately, for most of us, cultivar names must be expressed in a modern language with certain restrictions in length, form, etc. In order to be "accepted" names, they must be

Bill Frase crossed *N.* 'Castali Flora' with *N.* 'Orchid Star' to create the lovely *N.* 'Enid Frase.'

"published and established" under specific conditions set forth in the Code.

When you have a new and wonderful waterlily and consider naming and registering it, the first thing you have to determine is that you do indeed have a new cultivar. There are a number of criteria that need to be met, the most important of which are "Is it really different?" and "Do I have a number of plants that are uniform and stable in their characteristics?"

The full name of the new cultivar is the genus name, in this case *Nymphaea*, together with the name you give it, the "epithet." New names must be published in a dated publication (not electronic!) in order to be "fixed," protected under the Code.

An interesting example of how the Codes (ICBN and ICNCP) work has to do with *N. mexicana* forma *canaveraliensis* Frase 1958 published on page 220 in Slocum & Robinson's Water Gardening Water Lilies and Lotuses, Timber Press 1996. This *mexicana* is a larger flowered, larger leaved version than the regular *N. mexicana* usually seen and cultivated. It was collected by Bill Frase from the estuary that now divides the space shuttle launch pads at Kennedy Space Center, Cape Canaveral, Florida.

This name cannot be considered as valid under ICBN rules since it was not accompanied by a description in Latin! As a "selected" form of the species, it falls under the rules for cultivars in the ICNCP. It must be given what Piers calls a "fancy" name, one in a modern language with capital letters and single quotes around it. Since the Denver meeting, Bill Frase has named this selection *N. mexicana* 'Cape Canaveral', and the name is meeting the requirements of acceptance right here

By crossing *N.* 'Blue Beauty' with *N.* 'Panama Pacific', Bill Frase created the perfect delphinium blue *N.* 'Laura Frase'.

and now. It is being formally published and established in these pages of *Pond & Garden*.

What all this means is that we gardeners can go to our favorite garden center and, over time, have more assurance that the tags on the plants we buy are really indicative of the correct names being given to the correct plants and we go home with what we want. The "Boss" says it will be so.

THE NAMING OF Nymphaea 'Andre Leu'

by Kit Knotts

William Phillips discovered the beauty of native Australian waterlilies in a strange way. He ordered *N. gigantea* from a catalog that displayed a picture of the correct flower, but what he received, once he'd grown it out, was suspiciously different. Several growers experienced with *gigantea* confirmed the error and sent William tubers of the real thing.

In almost no time, William had plants from these tubers blooming and fell in love with the huge, rounded blossoms. The love affair was mutual since plants from the waterlily subgenus *Anecphya*, notoriously tricky to grow, absolutely thrive in William's heated greenhouse ponds in Memphis, Tennessee. Few have ever grown "the Australians" better or had more opportunity to observe and experiment with them.

Always with a love of tropical plants, William's interest gradually included tropical waterlilies and *Victoria*. In his greenhouses, just part of a developing 70-acre garden, a summer-like climate is maintained year round with the Australian lilies now the centerpiece.

N. 'Andre Leu'

By way of the IWGS email list, Andre Leu, from Daintree, Queensland, Australia, has always been generous with his knowledge of Australian native lilies. Because they can be hard to start and to keep going, interest has been limited, however passionate. With William Phillips leading the way, more is being learned about cultivation of these lilies, which will lead to greater availability.

Andre Leu with a large *N.violacea* on a recent collecting trip.
Photo by Barre Helquist

The source of most of these Australian beauties, though, is still the wild populations in Australia. Andre and Julia Leu's home in tropical North Queensland has to be one of the most beautiful in the world, where the wet, tropical rainforest meets the sea and the Great Barrier Reef. Andre collects and farms exotic tropical fruits in Daintree, also the starting point for expeditions in search of native lilies.

In April of 2000, noted plant collector Walter Pagels joined Andre in a trek across North Queensland to the place where another well known collector named Albert de Lestang once lived. For many years, it had been rumored that de Lestang had found a population of white *gigantea* that stayed open for 24 hours. Andre and Walter hoped to find them again.

N. 'Andre Leu'

"We traveled from Kuranda, near Cairns, across the Atherton Tablelands to Mt. Surprise on the first day," relates Andre. "We were stopped by floods and had to spend the night at Mt. Surprise. Next morning the rivers were down, so we continued across the base of Cape York peninsula to Normanton, stopping and collecting at every pool and watercourse we saw. That afternoon we reached Normanton where we found our first pure white *gigantea*, as well as many other colors.

"Normanton is in the Gulf of Carpentaria region. It is a dry region with a short three to four month wet season and virtually no rain for the rest of the year. It is a savannah-type climate, mostly grassed woodlands with open small- to medium-sized eucalyptus and acacia trees. It is rich in kangaroos, wallabies, parrots, snakes, crocodiles, and other wildlife.

"The next day we traveled to Gregory Downs, via Burke and Wills Road House where we stayed the night. We drove from there to the Lawn Hill area where Adels Grove, Albert de Lestang's old property, is located. Adels Grove is run as a shop/camping area. They had a scrapbook with copies of correspondence and biographies of Albert. Walter and I read and took notes. We learned that he named his property using his own initials.

"According to his notes, the seeds of the white flowered *gigantea* that he sent to the US via Kew Gardens in the 1940's and that George Pring named *gigantea* 'Albert de Lestang' did not come from that area but were collected by aboriginal people for him. I went down to the large waterhole on his property and spotted lilies. After hiring a canoe, Walter and I only found the common, light blue *violacea*. No *gigantea*. We drove around and spoke with local people, including stockmen, about possible locations of white flowered lilies, but no one had ever seen them. It was possible that they came from Domadgee to the north. Due to rains, the roads in that area were impassable.

"We were warned that storms would soon make the road back to Gregory Downs impassable, so we decided to return to Normanton, as that was the only place in over 700 miles of traveling that we had found white *gigantea*. On the return trip we found *gigantea* at a place called Sandy Creek, between Gregory Downs and Burke and Wills Road House. This site had many colors, from dark blue to almost white and a very pale light pink. The flowers of this group faded as they aged.

William Phillips with a cluster of *N. gigantea* flowers grown from Andre Leu's seeds. *Photo by Michael Phillips*

"We finally arrived back at Normanton at about 8 p.m. and, after a quick meal, we went down to the spot on the Norman River where we had found the white *gigantea*. To our surprise, there were flowers still open. About 10% of the flowers were open. We had found a source of the 24-hour flowering plants, which was the main purpose of this trip.

"The next day and night were spent searching for more areas with lilies. It was in the afternoon of that day that I spotted the deepest pink lily I have ever seen. I showed the plant to Walter, and he kept a look-out for crocodiles while I waded into the water to get it. This was one plant worth the risk, although most people in Northern Australia would think that I'm crazy as that particular area is infested with crocs. The largest crocodile in Austrailia, 43 feet long, came from there. I planted the lily into a pond at home and bagged the flowers for seeds. It went dormant after transplanting and still hasn't reappeared. None of my seeds have germinated yet."

With his characteristic generosity, Andre shared seeds from this expedition with several *Anecphy* aficionados in the US, including William Phillips. In his ideal environment, William soon brought the seeds from this amazing pink plant to bloom. All offspring are identical to the parent and to each other.

William began to wonder if these plants could be given a name and registered. The answer is yes. Article 2.16 of the ICNCP says "An assemblage of plants grown from seed which is repeatedly collected from a single provenance and that is clearly distinguishable by one or more characters (a topovariant) may be treated as a cultivar and named accordingly."

Piers Trehane, Chief Editor of the ICNCP, has personally confirmed that this group of plants meets all the criteria for naming as a cultivar. With Andre's permission, William has named it *N.* 'Andre Leu', and that name is formally validated here. It is still uncertain which species it belongs to (*gigantea*, *immutabalis*, *macrosperma*, or perhaps a new species), but the species name may be inserted between the genus and cultivar names when known.

William Phillips devotes an entire pond in his Memphis greenhouses to the collection of *N. gigantea* grown from Andre Leu's seeds, *N.* 'Andre Leu' in the foreground. Photo by Andrew Lohaza

"I have been collecting tropical plants for over 30 years and introducing new tropical plants, especially tropical fruits, to Australian horticulture from around the world for 25 years," says Andre. "This is the first time that anything I have collected has been named after me, and I regard it as a great honor."

Watch for a special article by Andre Leu and another on William Phillips and his garden in the next issue of Pond & Garden.

SELECTING the Right Pump FOR YOUR POND

by David A. Dec

If you buy a pump that is way too small, it may move only a trickle of water or possibly none at all. A bit larger pump can still be too small for good aeration, filtration, and surface skimming. Overloading an under-sized pump can result in a shorter pump life and more repairs. Often, people who initially buy too small a pump end up buying additional pumps, resulting in several pumps running for a higher operating costs. On the other hand, choosing a pump that is too large may not only waste money to run it but also damage plumbing and equipment.

In order to select the correct pump, follow these 5 steps:

- Determine the volume of your pond.
- Determine the desired water flow rate, based on the pond's volume.
- Determine the correct pipe size to move the desired water flow rate.
- Determine the water pressure needed to move the desired water flow rate through the system.
- Determine the proper pump that will produce the desired water flow rate at the required water pressure.

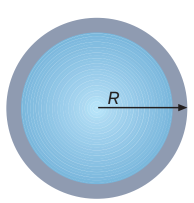
I. Determining the volume of your pond

The first thing you need to do is determine the volume of you pond. For a rectangular pond, multiply the pond's length (ft) x width (ft) x depth (ft) x 7.48 gallons ÷ cubic foot = U.S. Gallons. For other shaped ponds use the chart below.

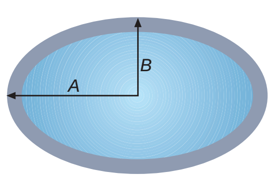
II. Determining the flow you want

If you have a pond that is under a few thousand gallons, you may want to turn it over 2 to 3 times per hour. This is comparable to large marine aquariums in which the water is turned over a minimum of 3 times per hour. If your pond is larger than this, you may want to turn it over only once every 2 hours.

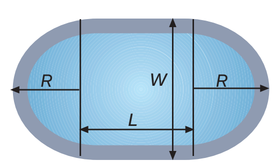
Peter Waddington, in his book Koi Kichi says the real volume of water a fish lives in is determined by multiplying the pump's flow per hour times 24 hours per day. For instance, 3,333 gallons/hour yields a "real volume" of 80,000 gallons that the Koi actually live in, regardless of the actual size of the pond. This implies that the pump's output is more important than the physical size of the pond. Obviously, then, people with smaller ponds want to turn them over more often than those with larger ponds.



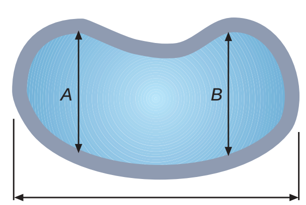
Area = R x R x 3.14
Volume = area x average depth x 7.48



Area = A x B x 3.14
Volume = area x average depth x 7.48



Area = (L x W) + (R x R x 3.14)
Volume = area x average depth x 7.48



Area = (A x B) + L x 0.45 (approx.)
Volume = area x average depth x 7.48

For example, if you have a 5,000-gallon pond, and you want to turn it over every $1\frac{1}{2}$ hours, simply divide the volume by the number of hours you want for a complete turnover. In this example, the flow needs to be 5,000 ÷ 1.5 = 3,333 gallons per hour (GPH) or 3,333 ÷ 60 = 55.5 gallons per minute (GPM). Knowing the desired flow rate is very important in determining the pipe and pump size for your pond.

Table One

	GPH	600	1,800	3,000	3,600	4,800	6,000	9,000	12,000
	GPM	10	30	50	60	80	100	150	200
d nom"	d act"	Velocity through pipe in feet per second							
"	0.608	*11.05*	*33.15*	*55.25*	*66.30*	*88.40*	*110.51*	*165.76*	*221.01*
"	0.810	*6.23*	*18.68*	*31.13*	*37.36*	*49.81*	*62.26*	*93.39*	*124.52*
1.00	1.033	*3.83*	*11.48*	*19.14*	*22.97*	*30.63*	*38.28*	*57.42*	*76.56*
1.25	1.364	*2.20*	*6.59*	*10.98*	*13.17*	*17.57*	*21.96*	*32.93*	*43.91*
1.50	1.592	*1.61*	*4.84*	*8.06*	*9.67*	*12.89*	*16.12*	*24.18*	*32.24*
2.00	2.049	*0.97*	*2.92*	*4.86*	*5.84*	*7.78*	*9.73*	*14.59*	*19.46*
2.50	2.445	*0.68*	*2.05*	*3.42*	*4.10*	*5.47*	*6.83*	*10.25*	*13.67*
3.00	3.042	*0.44*	*1.32*	*2.21*	*2.65*	*3.53*	*4.41*	*6.62*	*8.83*
4.00	3.998	*0.26*	*0.77*	*1.28*	*1.53*	*2.04*	*2.56*	*3.83*	*5.11*
5.00	5.017	*0.16*	*0.49*	*0.81*	*0.97*	*1.30*	*1.62*	*2.43*	*3.25*
6.00	6.031	*0.11*	*0.34*	*0.56*	*0.67*	*0.90*	*1.12*	*1.68*	*2.25*

III. Determining the correct pipe size for your pond

The Plastic Pipe and Fittings Association (PPFA) says PVC pipe should be designed for a maximum flow-rate velocity of 5 to 8 feet per second (fps) through the pipe. They say 8 fps is acceptable for pipe sizes of less than 1" in diameter, but it should be less than 5 fps for pipe sizes of $1\frac{1}{2}$" or larger. Higher velocities can actually cause pipe failure and rupture, as well as an astronomically large resistance to water flow, which necessitates higher horsepower requirements and higher operating costs.

How do you determine the velocity of the flow rate in feet per second? The equation is:

- Velocity in fps = .4085 x GPM ÷ d2
- Where GPM = gallons per minute, and d = inside diameter of the pipe in inches.
- Table One shows the results of these fps calculations for various pipe diameters (d) and flow rates in GPH and GPM.

For example, to pick a velocity that is less than 5 fps from the above table, look down the 3,600 GPH column (since we want a flow of 3,333) until we find an fps that is less than 5. When we do that, we see 4.10 fps corresponds to a $2\frac{1}{2}$" pipe.

Table Two

	GPH	600	1,800	3,000	3,600	4,800	6,000	9,000	12,000
	GPM	10	30	50	60	80	100	150	200
dnom”	dact”		Pump head in feet per 10 ft of pipe						
“	0.608	*7.80*	*59.66*	*153.65*	*215.37*	*366.92*	*554.69*	*1175.35*	*2002.42*
“	0.810	*1.93*	*14.77*	*38.05*	*53.34*	*90.87*	*137.37*	*291.08*	*495.91*
1.00	1.033	*0.59*	*4.53*	*11.66*	*16.34*	*27.83*	*42.08*	*89.15*	*151.89*
1.25	1.364	*0.15*	*1.17*	*3.01*	*4.22*	*7.20*	*10.88*	*23.06*	*39.28*
1.50	1.592	*0.07*	*0.55*	*1.42*	*1.99*	*3.39*	*5.13*	*10.87*	*18.52*
2.00	2.049	*0.02*	*0.16*	*0.42*	*0.58*	*0.99*	*1.50*	*3.18*	*5.42*
2.50	2.445	*0.01*	*0.07*	*0.18*	*0.25*	*0.42*	*0.64*	*1.35*	*2.30*
3.00	3.042	*0.00*	*0.02*	*0.06*	*0.09*	*0.15*	*0.22*	*0.47*	*0.79*
4.00	3.998	*0.00*	*0.01*	*0.02*	*0.02*	*0.04*	*0.06*	*0.12*	*0.21*
5.00	5.017	*0.00*	*0.00*	*0.01*	*0.01*	*0.01*	*0.02*	*0.04*	*0.07*
6.00	6.031	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.01*	*0.02*	*0.03*

One 2” pipe would be pushing the envelope, but we could use two 2” pipes; such as one 2” pipe from the bottom drain and another 2” pipe from the skimmer. Both pipes could terminate in the ends of a Tee fitting, equipped with valves for each, with the center branch feeding the pump. By the way, two 2” pipes have about the same area as one 3” pipe.

IV. Determining the water pressure needed from the Total Dynamic Head (TDH), or the sum of all the sources of pump head Ph, for your design

Head is best defined as “resistance to flow”. A higher head means you need more water pressure to overcome it. The term “head” is further modified by whether the resistance is encountered on the suction side of the pump [suction head (H_S) from the pond to the pump] or the discharge side [discharge head (H_D) from the pump to the pond]; whether it is caused by the standing height of the water (static head h_{sh} = height of the waterfall or fountain above the water’s surface) or by the movement of water through the system (dynamic head = h_d); whether the resistance is caused by simple friction due to fittings and pipe sizing (friction head = h_f) or by the equipment resistance (h_e).

$$TDH = H_S + H_D = (h_{sh} + h_d + h_f + h_e)_S + (h_{sh} + h_d + h_f + h_e)_D$$

In order to determine the total dynamic head (TDH) we need to consider all of these sources:

1. When water flows through pipe, there is a pipe friction or resistance at the inside surface of the pipe that needs to be overcome. That friction is a function of the diameter and length of the pipe.
2. When water flows through fittings like elbows, Tee’s, valves, check valves, etc., there is turbulence that also causes resistance to water flow. This resistance is a function of the total number of each type of fitting, and is expressed in feet, as an equivalent length of pipe, **not as pump head**.
3. When water flows through a leaf-basket / strainer, skimmer, drain, etc., there is more resistance to flow, depending on the open area of that component, as well as how plugged up the holes are with algae, leaves, etc.
4. When water flows through a filter, the resistance to the flow depends on the filter media, size of the filter, the internal plumbing, the flow rate, how dirty it is, etc.
5. When water flows through an Ultra Violet sterilizer the center UV tube increases the resistance to water flow of that section of pipe.
6. A heater, also, will increase resistance to water flow as it squeezes the flow down into a smaller 1” tube, makes a “U” turn in the heat exchanger, and adds more pipe length and fittings to the design.
7. Another source of TDH or Ph is the static lift in the pond design. An example of this is the height of a fountain, statue, or waterfall above the surface of the pond water.

This TDH or Ph is the most difficult calculation for everyone, because it is very complicated. Table Two is a table of the resistance in feet of pump head for every 10-foot length of pipe as a function of water flow.

Where do these values come from? The PPFA says to use the Hazen-Williams Equation.

The equation is:

$$Ph = 104.4 / C^{1.852} \times (GPM)^{1.852} / d^{4.8655}$$

Where Ph is the pump head in feet per 10 feet of pipe, GPM is gallons per minute, d is the inside diameter of the pipe in inches, C is a pipe smoothness coefficient that is 150 for new PVC; 140 for smooth walled copper, brass, etc.; 100 for ordinary iron pipe; and 80 for old iron pipe.

Lasco’s PVC fittings website also uses this equation to show the friction losses. However, they convert their results to Pounds per square inch (PSI) per 100 feet of pipe length.

According to Table Three, if we have 30 feet of pipe, and a flow of 3,333 GPH, the pump head due to the pipe alone, without any fittings, would be 4.22 * 3 = **12.66 feet of pump head for 1 ½” pipe**; 1.99 * 3 = **6 feet for 1 ½” pipe**; 0.58 * 3 = **1.7 feet for 2” pipe**, etc.

The next consideration is the number and type of fittings we plan to use. Following is a

Table Three

Pipe d”	90º elbow	45º elbow	Tee-run	Tee-branch	Check valve	Gate valve
0.50	*1.5*	*0.8*	*1*	*4*	*5.2*	*0.4*
0.75	*2*	*1*	*1.4*	*5*	*6.5*	*0.55*
1.00	*2.3*	*1.4*	*1.7*	*6*	*8.7*	*0.7*
1.25	*3*	*1.8*	*2.3*	*7*	*10*	*0.9*
1.50	*4*	*2*	*2.7*	*8*	*13.4*	*1.1*
2.00	*6*	*2.5*	*4.3*	*12*	*17.2*	*1.4*
2.50	*7*	*3*	*5.1*	*15*	*20.6*	*1.6*
3.00	*8*	*4*	*6.3*	*16*	*25.5*	*2*
4.00	*10*	*5*	*8.3*	*22*	*33.6*	*2.7*

Table Four			
Assuming 30’ length of 1 ¹/2” pipe	# of fittings	ft / fitting	Equivalent pipe length
Length of pipe			*30*
90º elbows	*6*	*4*	*24*
45º elbows	*2*	*2*	*4*
Tee’s - flowing through the run	*4*	*2.7*	*10.8*
Tee’s - flowing through the branch	*4*	*8*	*32*
Check valve 100% open	*1*	*13.4*	*13.4*
Gate valve 100% open	*10*	*1.1*	*11*
Total equivalent pipe length			*125.2*

table of the resistance per fitting, expressed in length of equivalent pipe in feet, **not in feet of pump head**. This is a very important distinction and is a source of much confusion.

Assuming we are using a total length of 30 feet of 1 ¹/₂” pipe, with six 90º elbows, two 45º elbows, four Tee’s, 1 check valve, and 10 gate valves. We use Table Three to construct Table Four.

Using these values, we get a total equivalent pipe length of 125.2 feet. Now we go to Table Two and find the pump head for a flow rate of 3,333 GPH, for a pipe diameter of 1 ¹/₂ “, which is 1.99 feet of pump head for every 10 feet of equivalent pipe length. Using these numbers to calculate the total pump head:

125.2 * 1.99 / 10 = 24.9 feet of pump head, which is due to the friction losses through the 1 ¹/₂” pipe and fittings.

When we perform this same calculation for all the pipe diameters at a flow-rate of 3,333 GPH, we get Table Five.

Table Five	
Pipe size	Ph (ft)
__”	*2,696.4*
–_”	*667.8*
1	*204.6* 1
__”	*52.8* 1
__”	*24.9* 2 *7.3* 2
__”	*3.1*
3	*1.1*

As you can see, the pipe diameter has a huge effect on the pump head requirement. If we choose the correct pipe diameter, based on the 5 feet per second velocity restriction, as is shown in Table One, we would use a 2 ¹/₂” pipe for a flow of 3,333 GPH. This would give us a pump head of 3.1 as seen in Table Five, and the guideline of “1 foot of pump head for every 10 feet of pipe” holds true for our 30 feet of pipe.

However, *if we choose any other size of pipe*, this guideline does not hold true, and can be way off the mark. **Choosing the correct pipe size for your pond is absolutely critical.** As seen in Table Five, if we use the 1 ¹/₂” pipe, the pump head would be over 8 feet of pump head for every 10 feet of pipe. Unfortunately, this is an easy mistake for a beginner to make, and it becomes very difficult to correct after the pond is constructed.

The next step is to add the pipe and fittings pump head to the other equipment pump head losses (not equivalent pipe lengths) to get the Total Dynamic Head (TDH), as shown in Table Six.

All these calculations have been based on ideal “new” pipe, fittings, and equipment. Older systems may have algae, hard mineral scale, or muck build-up on the piping walls, filters, strainers, valves, elbows, heat exchangers, etc., making the published numbers way too low; even assuming there are no rocks, gravel, or tree roots in the pipe. If any of these obstructions are present, the smoothness coefficient is no longer valid, and neither is the inside diameter of the pipe. In other words, the TDH pump head can be, in reality, much higher than that calculated for new pipe.

Table Six		
	Pump head	PSI
Pipe & fittings	*24.9*	*10.8*
Bottom drain	*2.0*	*0.9*
Skimmers	*2.0*	*0.9*
Leaf-baskets	*2.0*	*0.9*
80 watt UV	*1.9*	*0.8*
Filter	*14.3*	*6.2*
Heater	*5.0*	*2.2*
Static lift of 6 feet	*6.0*	*2.6*
TDH	*58.1’*	*25.2*

Another way of determining the TDH is to measure it, if your existing pump is working. Install a flow meter, plus a vacuum gauge on the suction side of the pump, and a pressure gauge on the discharge side of the pump. Every inch of mercury on the vacuum gauge is multiplied by 1.13 feet of head to get the suction head. Every PSI on the pressure gauge is multiplied by 2.31 feet of head to get the discharge head. By adding those two numbers together, you get the TDH at your existing flow rate.

V. Determining the best pump that will give you the proper flow and pressure

Now that we know the flow rate we want is 3,333 GPH or 55.5 GPM, and the Total Dynamic Head (TDH) for our pond design is 58.1 feet of pump head, we need enough water pressure to overcome that pump head.

Our next step is to check out the various performance curves for available pumps. Graph One is a typical performance curve. We find 55.5 GPM on the X or bottom axis, and draw a line up. Then we find 58.1 feet of pump head on the Y or side axis, and draw a line to the right. Where they meet is the pump that we want.

In this case, we want a pump that is a little less than a 1 horsepower pump. Our next step is to find the most efficient pump for our conditions. The most efficient pump will be the one with the highest Creech Pump Index (Water Flow in GPM x Water Pressure in TDH ft / Watts). If more than one pump have the same CPI, then the pump with the lowest amps will be the most efficient.

One thing to avoid is picking a pump with no “head” room. Make sure that your selection is not too close to the maximum pump head, in case you have not allowed for “dirty” pipes, fittings, etc., which eventually could result in no flow at all.

 David A. Dec is the author of various websites, such as http://www.ColoradoKoi.com , http://www.KoiFishPonds.com , and http://www.MoneySaverPumps.com . He has a Bachelor of Science in the Biological Sciences from the University of Chicago, and did his work for a Ph.D. in Physical Chemistry at the Illinois Institute of Technology. He has been involved in raising ornamental fish since the 1950’s.

SPIRANTHES CERNUA ODORATA 'Chadds Ford'

by Barry Glick

Like far too many native plants these days, *Spiranthes cernua odorata* 'Chadds Ford,' a native orchid, was discovered just as its habitat was about to be destroyed. Dick Ryan, an eccentric character with a passion for native orchids, found the plant back in the 1960's in a wet ditch near his hometown of Bear, Delaware. At the time, Bear was a rural crossroads town. Today, this former orchid habitat is overrun by tract homes.

It didn't take long for word about Ryan's exquisite discovery to spread. Dr. Merlin Brubacker, a plantsman with a keen interest in tropical orchids, was smitten by this denizen of temperate Delaware. In 1973, a division of the orchid grown by Dr. Brubacker received the coveted Certificate of Cultural Merit from the American Orchid Society.

Spiranthes cernua odorata 'Chadds Ford'

Nodding Ladies Tresses

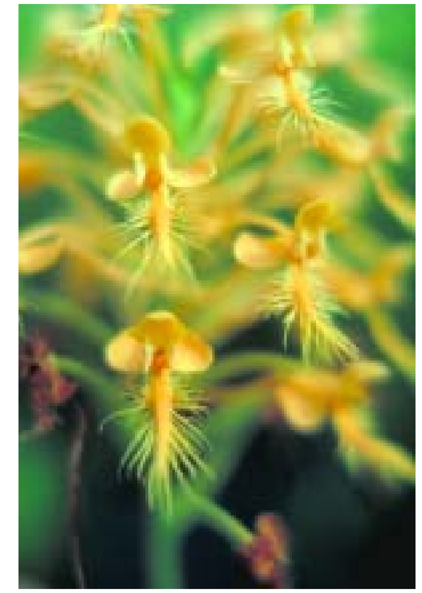
Spiranthes cernua odorata, a fragrant form of the species commonly known as nodding ladies tresses, is found in coastal regions of Southeastern states from Virginia to Florida, and west to Texas, where it flowers from fall through winter.

Nodding ladies tresses grow to about three feet tall, with 3 to 6 glossy, dark green leaves up to 8 inches long on the lower part of the stem. Its yellowish white blossoms are larger than those of the species, *Spiranthes cernua*, which is found throughout Eastern North America. Like other members of the genus *Spiranthes*, the flowers of this species are arranged in a twisted, spiral-shaped spike. (The name *Spiranthes* comes from two Greek words, *speira*, meaning spiral, and *anthos*, meaning flower.) Members of the species are called nodding ladies tresses because of the nodding habit of the individual florets that make up the flower spike.

A Smell of Jasmine

One of the most distinctive features of *Sprianthes cernua odorata* is its potent, sweet fragrance, often compared to that of vanilla or jasmine. 'Chadds Ford' is a wonderful cultivar – a vigorous grower with large, extremely fragrant flowers. Although the plant was discovered in Delaware, it was named in honor of Chadds Ford, the town in southeast Pennsylvania where Dr. Brubaker lived.

Ever since the dawn of gardening, orchids have had a mystique. In the words of botanist Welby R. Smith, who has written an entire book on the orchids of Minnesota alone, "Orchids are often thought of as rare, fragile objects d'art, existing only in the steamy tropical forests or Edwardian greenhouses. In reality, nothing could be further from the truth. Orchids occur worldwide from the arctic tundra to Tierra del Fuego. They are absent only from the driest deserts and the wettest aquatic habitats." Orchids make up one of the largest plant families, with 725 genera and more than 20,000 species, and account for some 7 to 10 percent of all flowering plants on Earth!



Cypripedium calceolusor, the small lady slipper, blooms from April through August. Bees are attracted to the smell of nectar that does not exist within the pouch and must exit the pouch through two small channels at the rear of the pouch, carrying or depositing pollen as they leave.

Nearly everyone is familiar with the multitude of orchids from the tropics, where the majority of orchids live. In most regions of this country, these must be grown as houseplants. Few gardeners are aware of the surprising diversity of terrestrial orchids native to the U.S. (As the name implies, terrestrial orchids are those that are rooted in soil. All orchids in temperate regions are terrestrial; most tropical orchids are epiphytic, meaning they grow on another plant—but aren't parasitic—usually in the canopies of the tallest trees.) Some 216 species of terrestrial orchids are native to North America. Among the many genera of native orchids are *Cypripedium*, the lady slippers; *Isotria*, the whorled pogonias; *Platanthera*, the fringed orchieds; *Pogonia*, the beard flowers; *Goodyera*, the plantain orchids; *Listera*, the twayblade orchids; *Corallorhiza*, the coral root orchids; and *Tipularia*, the cranefly orchids.

The orange fringe orchid, *Habenaria cilaris*, acquired its name from *habena*, Latin for reins or narrow strap, that refers to the narrow lip of some species of this plant. When a long-tongued moth or butterfly sips nectar from the deep spur, grains of pollen on a sticky disk that protrudes below the anther attach to the insect's head in just the right position to be left behind on the stigma of the next blossom visited.

An Elusive Prize

Until recently, orchid lovers have been able to appreciate native orchids only in the wild, not in the garden. Many of these plants are slow to propagate and, therefore, are not readily available from commercial sources. For decades, orchids have

The grass pink, *Colopogon tuberosus*, grows from 1-3 feet tall and blooms from May through August. It is one of the few orchids with flowers presented right side up, bearing a single, grass-like leaf. When a nectar-seeking insect lands on these false stamens, the lip drops forward, and the insect falls onto the column below. As it scrambles to right itself, the insect either picks up or leaves pollen behind.

been dug up from the wild by unscrupulous collectors who have decimated entire plant populations. This, in addition to loss of habitat to development, are the major threats to the long-term survival of many orchids, as well as of other native species. For this reason, it's important to buy native orchids only from nurseries that are propagating them vegetatively, not collecting them from the wild. Fortunately, in recent years, there have been great strides in propagating even the most difficult orchids, such as the lady slipper, *Cypripedium reginae*, which is being propagated by tissue culture by Bill Steele of Spangle Creek Labs in Minnesota. (sci@uslink.net)

Orchids are not only difficult to propagate, they also have a reputation of being almost impossible to grow. The most commonly accepted theory on why they're so temperamental is that the symbiotic relationship with mycorrhizal fungi found on the root tips, essential for the breakdown of nutrients in the soil to forms the plants can use, is difficult to simulate in a garden setting. *Spiranthes cernua odorata* 'Chadds Ford' is the exception to the rule. It's not only easy to grow, but it also forms colonies quickly.

Pink Lady's slipper, *Cypripedium* spp. gain their name from the form of the flower that looks like a slipper. No nectar is contained in the slipper-like pouch, but bees are attracted by the scent of nectar from inside. As the bee exists the flower, it leaves pollen on the female stigma.

A Prodigious Beginning

In August 1992, Dr. Richard Lighty, director of the Mt. Cuba Center for the Study of Piedmont Flora in Greenville, Delaware, gave me a 6-inch pot of 'Chadds Ford.' I kept the plant in a moderately heated greenhouse (45 F). By December 30, I was able to divide out thirty-two 2 ? inch pots, eighteen 4-inch pots, and put the stock plant back in its original pot.

The following spring, I transplanted several divisions outside in the garden. By midsummer, flower buds had begun to form. In late summer, my garden was graced with 18-inch spikes of waxy white, orchid flowers, tinged with green and scented like vanilla. The flowers persisted into late fall.

Like others of its species, 'Chadds Ford' prefers wet feet. However, it will do perfectly well in any rich, moisture-retentive soil, in sun or shade. Given these conditions, this plant, which is stoloniferous, will multiply in no time at all. I highly recommend it, even for the novice gardener.

Further Reading

If you'd like to learn more about native orchids, take a look at the following books. Some are out of print, but they can be found in any good horticultural library:

Hardy Orchids by Phillip Cribb & Christopher Bailes. Timber Press, Portland, 1989.

Orchids for the Outdoor Garden by A.W. Darnell. First published by L. Reeve & Co, Ltd, Ashford, Kent, 1930. Reprinted by Dover Publications, New York, 1976.

Wild Orchids of the Middle Atlantic States by Oscar W. Gupton and Fred C. Swope. University of Tennessee Press, Knoxville, 1986.

Flora of West Virginia by P.D. Strasbaugh and Earl Core. Seneca Books, Morgantown, 1978.

Orchids of Minnesota by Welby R. Smith, University of Minnesota Press, Minneapolis, 1993.

Where to See Native Orchids

One of the most exciting things you can do is visit a wild population of native orchids. A great place to see them is at the Cranberry Glades in the Monongahela National Forest in Pocahontas County, WV. Almost every state has a native plant society that you can join and that will direct you to wild orchid populations in your area. A list of these groups can be found in Brooklyn Botanic Garden's Gardening with Wildflowers & Native Plants, handbook #119, available for $6.95 plus $3.75 for shipping and handling (NY City and State residents must include sales tax) from BBG, 1000 Washington Ave., Brooklyn, NY 11225-1099. You can also see native orchids at public gardens, including BBG's Local Flora Garden, Garden in the Woods in Framingham, MA, University of Wisconsin Madison Arboretum, and Berry Botanic Garden in Portland, WA.

The Dragon's Mouth Orchid, *Arethusa bulbosa*, once included in the family of *pagonia* is now classified as its own rare species of bog orchid. It blooms briefly before producing a grasslike leaf. Pollinating insects, usually bees, are attracted by the flower's sweet scent.

The endangered Showy Lady's Slipper, *Cypripedium reginae*, is the provincial emblem of Prince Edward Island and the state flower of Minnesota. It may take up to sixteen years to bloom for the first time.

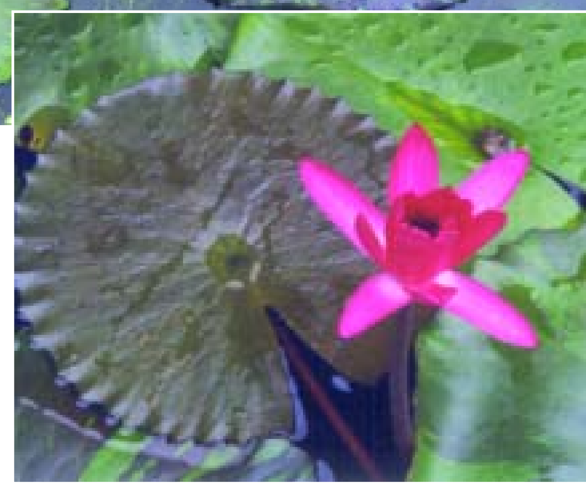
Reprinted from Plants & Gardens News, Spring 1995, published quarterly by the Brooklyn Botanic Garden. ©1995 Brooklyn Botanic Garden. Barry Glick, owner of Sunshine Farm & Gardens in Renick, WV, is also known as Glicksterus maximus aka The Cyber-Plantsman. He can be reached at 304-497-2208 or by e-mail at barry@sunfarm.com. Barry sells over 10,000 different plants from his nursery. Take a peek at his gardens and plants at his website: http://www.sunfarm.com. You can subscribe to Barry's "Glick Pick of the Week," an e-mail plant newsletter, at www.sunfarm.com/subscribe.phtml.

Your Pad or Mine?

WATER LILY LEAVES UP CLOSE AND PERSONAL

by Paula Biles

Unlike roses, orchids, or other plants famous for their gorgeous flowers, the leaves of water lilies are also attractive. In fact, they have been a focal point for gardeners, scholars, and poets for centuries. Lily pads have been painted, drawn, and sculpted from the earliest times to the present. They have been used to decorate art and other objects from Egyptian tombs to Tiffany glass to Budweiser commercials. Lily pads are definitely the most distinctive element of any pond landscape.

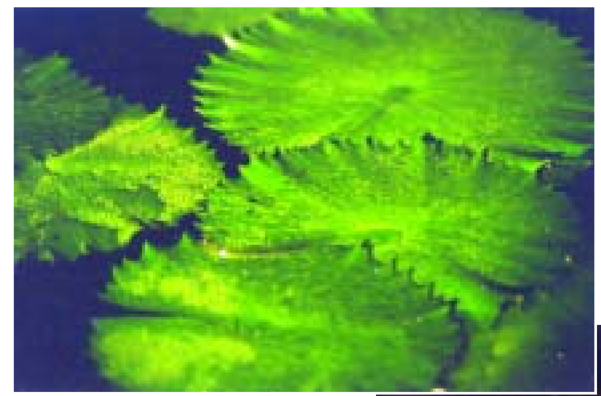


(top) Strongly mottled leaves are more frequently found on tropical lilies like this one than they are on hardies. The patterns sometimes fade on older leaves, as can be seen on the pads to the left.

(lower) Night-blooming tropical water lilies bear very distinct leaves. Often they are bronze or maroon and always have a fluted edge, usually with slight points. Compare the darker, night-bloomer leaf in the center to the other day-blooming tropical lily pads around it.

Lily pads serve many useful functions for the pond and the lily, besides being pretty and giving frogs a place to hang out. They prevent the pond from breathing too hard by keeping the temperature more constant and by regulating the exchange of gases and evaporation. They provide shade for the water and the fish in it; absorb heat from the surface; exchange gases in the plant; absorb sunlight and convert it to energy for the plant; and keep fish predators flummoxed. In some cases, they also serve as a method of lily reproduction.

Water lily leaves are an excellent example of nature's efficient and beautiful designs. Because they are so attractive, it's easy to overlook what engineering marvels they are, ideally adapted to their environment. Their aquatic world has constantly changing water levels, sometimes several feet per season. The lily is perfectly designed for these conditions with floating lily pads at the end of long, flexible stems (petioles, in scientific jargon). They easily take up any variation in water level by floating closer or further from the plant's center. If there is a drastic increase in water depth and the leaves are forced under water, their stems grow a little longer until the pads are on the surface again. You may notice this when you set a brand new lily in your pond deeper than it was at the store. The leaves may be submerged at first, but by the next day,



Some night bloomers have extremely fluted pads, like this one, captured in the early morning dew.

they're floating. This also happens at the beginning of the season when water gardeners place lilies very close to the surface (2-4") where the water is warmest and the sun is brightest. This speeds the lilies' new growth and shortens the time it takes to begin the season. After the plants develop some decently sized leaves, they are lowered to the preferred depth where their stems lengthen until the pads are on the surface again.

The two surfaces of a lily pad differ greatly. The upper portion is all that we see, since the underside adheres to the water like a magnet, and it takes a very strong wind to overturn it. Water droplets on the top surface bead up and run off, leaving it always dry. This is due to a waxy, waterproof coating (cutin), which contains and protects the leaf's breathing pores. It also makes the leaf very buoyant and difficult to submerge. Unlike other plants, lilies have only one leaf surface to absorb available energy from the sun for photosynthesis, so it must be extremely efficient and not waste any. To maximize photosynthesis and trap heat, the underside is usually a purplish or reddish color that prevents sunlight from passing through the leaf and into the water. This both increases the lily's

Hardy water lily leaves are usually round with a smooth edge. Most often they are uniformly green, although occasionally they have darker flecks or speckles. However, 'Arc en Ciel' is unique with cream and pink splotches.

Tropical water lily pads are oval-shaped with wavy edges, as seen in these three examples. Some varieties are viviparous with a new, little lily growing from the center of the old leaf. At first, a slight nub (see pointer) grows in size, and then it begins to form leaves and roots. Eventually, it develops into a small plant, able to survive on its own.

growth and keeps the water cooler.

Leaf sizes may range from 2 inches to 2 feet in diameter. Leaves and stems transfer gases down to the base of the plant. The petiole is actually a big, supple straw that carries oxygen from the pad down to the roots growing in the anaerobic pond bottom or pot. Even though the pads may appear relatively thin, they are actually quite tough. They withstand most natural conditions, except hailstones, and remain whole.

Leaves also function as gauges to tell us how the water lily is growing and if it needs fertilizer. As with most plants, nutrients are stored in the leaves, so when the leaves die, the average lily pad lasting about 3-4 weeks, those nutrients are lost to the plant. In nature, the dead leaves would be recycled at the pond bottom and their nitrogen, phosphorus, and potassium reused again. However, in our ponds, yellowing leaves are trimmed away and the residual nutrients are lost to the plant. For maximum growth and blossoms, the plant requires regular supplements of fertilizer. As soon as the water lily needs food, it signals by reducing the size and number of pads it produces. After a dose of fertilizer, its response is fairly immediate. Usually within a week or two, the newly emerging leaves are larger and/or more numerous.

Hardy water lily leaves have the classical shape pictured in paintings and drawings. They are almost round with a smooth edge and are generally plain green, although a few have faint mottling. Each pad is slightly thickened and waxy and usually stays fairly small, about 2”-10” in diameter.

Day-blooming tropical lily pads are oval with a wavy irregular edge. They are often green but may also have blotches, streaks, or mottling of darker colors. Their leaves are larger than the hardies’, 4”-24”, and they are thinner. Some varieties of tropical day bloomers are viviparous, which means they produce new little lilies on the pads where the leaf joins the stalk. In these cases, there will be a small nub on the leaf where the baby will later form. Occasionally, the plantlet completely develops while still attached to the mother leaf.

Night-blooming tropical lily leaves are the easiest to identify. Usually, their colors range from dark green shades to bronze or maroon. Their overall shape is oval, like other tropical water lilies. However, their wavy edges are fluted and have slightly pointed tips. None of the night bloomer’s pads are mottled, but there might be some color variation between the oldest and newest pads on the plant.

Koi keepers are part chemist, part biologist, and part engineer. As you can see, plant aficionados are all of these, too, and this knowledge gives them an appreciation of how their plants fit into the aquatic environment, plus helps them to identify types of lilies when name tags aren’t around. Water gardeners interpret what the leaves are trying to tell them and realize their importance for the health of their pond.

Reasons to Classify a Lily by Its Leaves

• Sometimes you need to figure out which lily is which, either before or after it’s bloomed in your pond.

• It’s important to classify lily types when buying them, since they’re usually not blooming or labeled. By identifying the leaf, you can tell whether it’s a hardy, a day bloomer, or a night bloomer.

• Some lilies are purchased for the pad’s appearance rather than the blossoms.

• You want the right lily type for your plant hardiness zone to ensure growth and survival.

• You may want a viviparous water lily to grow lots of plants to share. Now you can identify viviparous varieties even before they produce.

• At club swap shops, it will help to identify the kinds of lilies being offered.

• If you are ever on *Jeopardy*, you would be able to quickly buzz in and tell Alex the correct answer for this clue: The type of water lily with smoothly rounded leaf edges grown in Monet’s pond.”

• You’ll impress your friends with your remarkable ability to identify lily types. Imagine their amazement when you ask the host on a pond tour, “What color is your night bloomer?”

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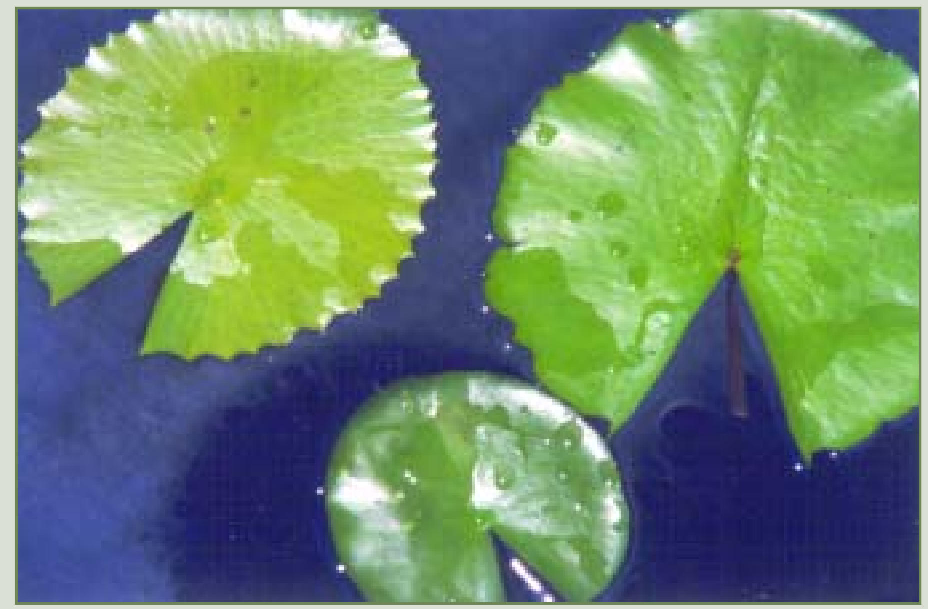
WHICH IS WHICH?



This is a “Pop Quiz” to see if you can identify the different classes of water lilies based upon their leaves. Carefully look at the photo above, write down your answers, and then turn to page 93 for the answers. Which is the hardy water lily, the tropical day bloomer, and the tropical night bloomer?