ON THE CULTIVATION OF THE GIANT MALAYSIAN PITCHERPLANT (*NEPENTHES RAJAH*)

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Nepenthes rajah ranks among the most spectacular pitcherplants in the world: large crimson traps with massive frilled rims (see Plate 19 in Kurata 1976). It also has a solid reputation for being difficult to grow (e.g. Douglas 1884). Miller (1906) states, "To grow the Rajah may well be regarded as the summit of the gardener's skill." Despite many introductions, the species remains extremely rare in cultivation. Failure to grow this remarkable carnivorous plant stems, in my opinion, from a poor understanding of its cloud forest environment on Mt. Kinabalu. In this article, I describe my limited success with *N. rajah,* particularly how I have tried to simulate its natural environment at the University of Utah. Since this pitcherplant is considered endangered, failure to cultivate it has important consequences for the conservation of wild populations on Mt. Kinabalu (see article by Dr. Faith T. Campbell in this issue).

Many years ago the Director of Sabah National Parks sent me a small packet of *N. rajah* seed for my research. I now have 12 robust plants, each over 9 inches in diameter. If they continue to grow at present rates (1 new leaf/month and 1.75x size increments), they should be mature within 1 year. I suspect this giant pitcherplant can be raised from seed to maturity in less than 4 years.

Natural Conditions on Mt. Kinabalu

N. rajah grows in cloud forest between 1650 and 2650 meters elevation on Mt. Kinabulu. Kurata (1976, page 61) describes its habitat as "sunny and wet" and "fond of wet places like swamps or the surroundings of a water fall." To the best of my knowledge, this is the only published description of *N. rajah*'s habitat. For a general description of cloud forest environments, see Grubb (1977), Whitmore (1975), and Lawton (1983).

In 1972 I visited Mesilau Creek. Here the pitcherplants grow among short grasses on a steep slope under a stunted forest (15 feet tall) over Oligocene serpentine. Seedlings were common only on a recent landslide. *N. rajah,* like most carnivorous plants, colonizes semi-bare ground created by disturbance.

Due to the open canopy of the stunted forest, the pitcherplants are exposed to the full sky. At these elevations, light conditions are a bright haze with short periods of full sun, usually in the cool morning. The broad leaves of *N. rajah,* therefore, are rarely exposed to long periods of full hot sun. Throughout the day, frequent mist and cool air temperatures keep leaves from burning.

Rainfall at these elevations on Mt. Kinabulu may exceed 150 cm per year, distributed evenly throughout the year (data for Kambarangoh, see Lowry *et al.* 1973). During the day, humidity may fluctuate at ground level, but at night, as temperatures drop, local humidity may rise to saturation.

Unfortunately, I have not found data for day and night temperatures at any *N. rajah* site. From my brief visit to Mesilau Creek, however, I would guess 65°-70° (day) and 55°-60° (night).

In general, cloud forest soils are peaty, hence acidic, nutrient-poor, constantly wet, and sterile (see Grubb 1977). Due to serpentine, soils at *N. rajah* sites may also be toxic. Extended periods of heavy rainfall may oxygenate the peat layer and hence release nutrients stored in organic matter.

A pitcher of *N. rajah* captures substantial amounts of insect biomass during its lifetime, as much as several grams for the largest traps (personal observation). Pitcher contents can only be described as a "foul swill" of putrid insect victims, dead leaves, and twigs.

Greenhouse Conditions at the University of Utah.

During those rare moments when the sun shines, the cloud forest environment feels like perpetual spring. It is like standing in the brilliance of the driving cool mist from a waterfall. This contrasts markedly with the dark, oppressive, hot, stuffy artificial greenhouse environments created by growers for lowland *Nepenthes* species.

In general, I grow *N. rajah* "hard" (high light, cool temperatures, fluctuating humidity, low soil nutrients). In my opinion, it is a serious mistake to grow this species "soft" (dark, warm, constant high humidtiy, fertilizer in soil). Under such soft conditions, plants produce thin, over-sized leaves and no traps. In this weakened state, they become prone to stress and disease. From correspondence with my trading buddies, I know of severa scores of *N. rajah* plants which have died under soft conditions.

In my opinion, the 3 most critical aspects of cultivating *N. rajah* are:

1). **Mist plants heavily, at least 5x per day.** This pitcherplant species will not produce traps unless heavily misted. In fact, its threshold for trap production occurs at much higher humidities than those of other *Nepenthes* species, probably because its open bowl pitcher form has high evaporation rates from it and will not function efficiently at lower humidities. Hence, there has been natural selection for plants which produce traps only at the highest humidities.

2.) **Increase light levels, just short of burning.** I find that traps form only at high light levels. In fact, trap size increases with light intensity and appears due entirely to instantaneous photosynthetic input from its particular leaf. If leaves are misted regularly and air temperatures are lower, leaves will not burn as readily at higher light levels.

3). **Feed traps insects, not fertilizer.** Once traps have formed under high mist and high light conditions, the only direct way to put nutrients into a plant is to feed traps with insects. *N. rajah* has a poorly-developed root system and therefore fertilizer on the soil will not get into the plant readily. Instead, it will promote microbial activity, which can cause the plant to rot, especially if grown soft. Obviously, feeding insects through pitchers does not risk the possible loss of an entire plant. I also find that putting fertilizer into traps causes an internal imbalance in nutrients, which eventually stops whole plant growth. Furthermore, it is difficult to know how much fertilizer to put into a given trap, whereas insect biomass can easily be estimated from natural capture rates. Fertilizer in pitchers can also increase microbial action and therefore wipe out important enzyme systems for insect digestion.

I feed ⅓ of the pitcher volume with insects over 10 - 15 days, which grossly approximates natural capture rates. Small traps receive small ants and flies, whereas large traps get large insects, as many kinds as possible. I maintain fluid levels in traps with a pipette. If fed too much insect biomass, the top of a trap will die. Fed traps will turn from red to green. A UV light trap will catch pounds of insect biomass, which can then be frozen for future use.

Insect resources may be particularly important for *N. rajah.* This beast may be more-dependent on insect resources than other *Nepenthes* species. Undoubtedly, its large, long-lived, woody traps would have higher metabolic costs to produce than those of small, short-lived, flimsy traps, especially if they were less photosynthetic compared to green traps. By inference, the benefit derived from *N.*

rajah's traps must also be greater. To ascertain the truth of this hypothesis, I have been constructing growth rate curves for various *Nepenthes* species as a function of the amount of insect biomass fed to plants. The slopes appear to be steeper for *N. rajah.*

I pot my plants in Canadian peat moss and white quartz sand (1:1). As the peat breaks down, it releases nutrients to the plant. This may be particularly important for establishing small seedlings or weak plants. Since the sand is coarse (#8 sand blasting silica grit), drainage is fast. I repot every 2 years or whenever the peat breaks down. There will be little disturbance to fragile root systems when repotting if you wash the soil mixture away from the plant. Moss stabilizes the soil surface.

I water plants heavily each morning with 99.95% pure water (reverse osmosis, then deionized; 18 meg-ohm). I use a fog nozzle so that the water will be heavily oxygenated.

Day temperatures are about 70°. I have found that newly-expanding leaves will develop black blotches of sun-burn if exposed to higher temperatures, especially during the summer, when light levels are naturally highest. Night temperatures are between 55° and 60°. During the summer, an evaporative cooler maintains night temperatures about 70°. Cool night temperatures during the summer may be crucial for success with this species.

One word of caution: a weak *N. rajah* plant must adapt *gradually* to the limits of this "hard" environment. If grown "soft", it will be badly stressed under such harsh conditions. It will become yellow and re-veined, grow slowly, and probably back-slide in size. When first placed under my conditions, soft-grown *Nepenthes* typically shrink to ⅓ their size. I find that *N. rajah* adapts slowly. A plant will begin to change appearance only after 3 or 4 months of feeding traps with insects. It will produce larger, deeper green leaves and considerably larger traps. At this point, light levels can be increased again. Only a well-fed plant can tolerate higher light levels.

Readers who wish to obtain their own *N. rajah* plants should know that the Giant Malaysian Pitcherplant is considered an endangered species (only 2 small populations are known to exist within Kinabalu National Park). It is fully protected by Malaysian wildlife laws and by CITES. *Do not buy illegal field-collected plants.* Such plants invariably die within 3 months.

The author would like to correspond with other carnivorous plant enthusiasts who have attempted to grow *N. rajah* in order to learn better how to grow this remarkable beast. Since I plan to keep my 12 plants as stock to create hybrids with other *Nepenthes* species, I do not wish to trade or to sell any plants at this time.

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(See front and back covers, this issue, for photos of *N. rajah* grown by Thomas Gibson.

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COVER PHOTOS

Front: 2.5 inch pitcher of *Nepenthes rajah.* (Photo by Thomas C. Gibson.)

Back: 5 inch seedling of *Nepenthes rajah.* Note increments of leaf size. (Photo by Thomas C. Gibson.)

See article, page 6.

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