Growing high elevation tropicals: Building a chamber to accommodate cool growing tropicals, alpines, and species requiring cold dormancy

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In addition to my love of Gesneriads, I've found myself intrigued by carnivorous plants, especially species that grow high in Southeast Asian cloud forests, where temperatures drop from the low 15°C's to occasional brief frost. Not only does the temperature drop occur, but humidity simultaneously rises to nearly 100%. Carnivorous plants are not the only plants that require cool drops in temperature for health and blooming. Some plants require seasonal temperature drops for a winter rest, still others require a temperature reduction to induce blooming. Orchids, flytraps, alpine gesneriads, rarer species, such as *Saintpaulia goetzeana*, *Sarmienta scandens*, and even some *Columnea*, are among the gesneriads that enjoy cooler nights than the typical household environment can provide.

I had always avoided obtaining any of the exotic and often pricey carnivorous plants I saw in books and online, because I was put off by the prospect of providing the humidity and temperature drops they require. Living in Maryland with hot summers and cold winters and with humidity in the teens, this is not the easiest place to grow these species without a specially designed greenhouse. Not provided with the nightly chill, some fail to thrive, at best, while many will actually perish, literally growing themselves to death. The plant is essentially kept at full metabolism, as if it were a human being, jogging perpetually on a treadmill. Its respiration is increased and it just exhausts itself. Since many of these species cost over $100 for a small start, they are not plants to experiment on.

I recently decided it simply couldn't be impossible to cool a small area and grow some of these lovelies. I knew there were all sorts of methods using water cooled radiators, adapted wine chillers, refrigerator innards, air conditioning units, and even the über simple replacing of frozen water bottles into a terrarium at night. I researched many options and met with frustration at their unsuitability for the average person, either being too hard to regulate, expensive, or otherwise not possible to use inside a home. It was actually months of research and participating in online discussions that finally gave me a viable idea.

Johnston Controls makes a digital thermostat, which is designed to turn a conventional chest freezer into a wine chiller, keeping the temperatures well above freezing. A chest freezer has the advantage of being easily lit, with traditional sized fixtures, being well insulated, and reasonably inexpensive (for those inclined to grow such pricey plants). The concerns with using a freezer were that it would be so well insulated that it would not sufficiently warm during the day or that it may exhaust itself by cycling on and off, multiple times per day. Deciding to give it a try, the freezer, Johnston Control, and 6 tube T5 fixture were purchased.

A lid was constructed from framed plexiglass and it was time to play!

First, I was disappointed that the thermostat gave one option for temperature setting and was not paired with a built in timer. This meant I would have to place the thermostat (the freezer plugs directly into the thermostat, which plugs into a power source) on a timer and manipulate the on/off periods to facilitate a nightly cooling and daily warming. Second, it became apparent that the

freezer, being so well insulated, would become an oven under the intense lighting required by the plants. The lid of the freezer was easily removed and replaced with the plexiglass lid and the experimentation began.

In my excitement, I plugged in the light, after setting the thermostat to cool the freezer to 13°C, from 12 pm until 6 am, with the intention that the light would allow for a gradual warming to the maximum day temperature — ideally between 24°-28°C, with below 26°C preferred. I started with the chamber/freezer at room temperature, plugged in the light and watched the temperature for an hour. The temperature only went up 1.7°C, so I thought I was safe to put one of my beloved carnivorous plants inside. Anxious to let it experience ideal conditions, with an appropriately cooled night, I placed the plant inside and went up for supper. About 3 hours passed and I went to check on the temperatures and noticed the plastic cup keeping the plant enclosed for humidity appeared melted! My nightmare was confirmed when the internal temperatures read 66°C and the once prized piece of my carnivorous menagerie, *Nepenthes hamata*, was reduced to brown mush. That's right, I steamed a $150.00 plant! I was not pleased, but pressed on.

It was obvious that the lack of programming options in the thermostat would not allow me to set an ideal daytime temperature, while achieving the ideal night temperature drop. I would have to have the freezer cycle on and off, while the light was on, in order to keep the growing chamber cool, but not too cool! It was a matter of a few days of tweaking and monitoring cycles of on time to keep the temperatures suitable. Of course, that wasn't made simple either, due to the fact that most timers run on 15-minute increments and these increments of time dropped the temperatures too low, creating undesirable temperature swings. Other timers that allow single minute increments of time only had 7 program cycles, so I had my work cut out for me. Using a digital timer, I perfected the on/off cycles to keep my daytime temperatures at no warmer than 28°C and no lower than 23°C, with a minimal amount of fluctuation.

It was after further consideration, I decided to use the multiple on and off cycles as an advantage and time my lights and nightly cooling to allow for a gradual nightly cooling and gradual daily warming, with a stable daytime high. I decided, since the freezer came with a built in shelf, I'd utilize a plastic tote filled with water to create a level surface and act as a stabilizer for the temperature. The temperatures were tweaked to utter perfection and even included the luxury of a very natural daily rise and nightly fall. The "night" cooling cycle begins at midnight and continues until noon. The light comes on at 10 am, so that when the freezer cycles off at 12 noon there has been a gradual rise in temperatures with a correspondingly gentle rise in plant metabolism. During the "day", the on/off cycles for cooling the chamber starts with the freezer turning on for 10 min at 2:15 pm. This prevents a fast rise in temperature and allows for a gradual temperature increase. Then every 2 hours thereafter, the freezer comes on for 12 minutes. The extra minutes account for the tendency for the temperature to rise more quickly the longer the lights are on, due to the freezer's insulating capacity. The final two "day" cooling cycles occur after the lights are off at 10 pm (10:01 pm-10:13 pm) and again from 11 pm-11:15 pm, to allow for a gradual reduction in temperature and plant metabolism. Even if the engineers of the world weren't forward thinking enough to build timers and thermostats that met my need, I was most certainly a GENIUS!

Next, I noticed the humidity would need to be addressed. Unlike a refrigerator, a freezer of this type has no circulating fans and does not dry out the air significantly. The humidity still needed to be increased, because young plants, smaller than 15 cm in diameter require RH above 90% and the humidity naturally raises in tandem with the nightly temperature drop , due to the descending clouds and fog of the cloud forest. This was worrisome, because small humidifiers generally only run for

Figure 1: Ultrasonic humidifier with shop vac hose inserted into the output.

Figure 2: Shop vac hose from the humidifier, placed through a hole drilled through the lid, for added humidity.

one full day, before needing to be refilled and I find that too much bother, as well as an impossibility, when traveling. Nevertheless, I purchased a 7.6 liter capacity ultrasonic humidifier (Fig. 1); having had experience with them for use with terrariums before. I purchased a vacuum cleaner hose, drilled a hole in the plexiglass freezer lid, placed the working end into the output of the humidifier and the end of the hose destined to fit onto the shop vacuum into the drilled hole and there it was — the start of the solution to desired humidity (Fig. 2).

Some other small improvements and tweaks were made, including placing the humidifier on a timer to run every hour for 30 min at night and for 15 min increments during the day, every 2 hours. I only need to fill the humidifier weekly and humidity is maintained above 90% at all times, with the chamber being filled with a very naturalistic fog, overnight and into the morning. Weather stripping was used on the bottom edge of the lid to provide a seal and a small USB fan was added for circulation, which runs at all times (Fig. 3). Finally, I cut down some lighting baffle to fit the internal dimensions of the chamber, ordered some plastic trays that fit, placed live sphagnum moss in the trays, placed the baffling, and then placed the individual plant reservoirs on top of the baffling. I utilize wick watering, where the plants are potted with a piece of acrylic yarn run through the pot and out the bottom. The dangling excess is placed in a container of water, usually a plastic food container with a hole cut in the lid. The reasoning for placing the moss under the baffling was to have a place to grow the moss, promote humidity, and have a place, shaded by the plants above, to grow plants needing lower light (Fig. 3). Currently in the chamber are several carnivorous plant species, ant plants, ant ferns (these are plants and ferns that have symbiotic relationships with ants), *Saintpaulia goetzeana*, and soon to be some orchids and *Sarmienta scandens*. Among the carnivorous species are *Nepenthes edwardsiana*, *N. attenboroughii*, *N. hamata*, *N. inermis*, *N. mikei*, *N. ventricosa*, *Utricularia reniformis*, and *Heliamphora pulchella*.

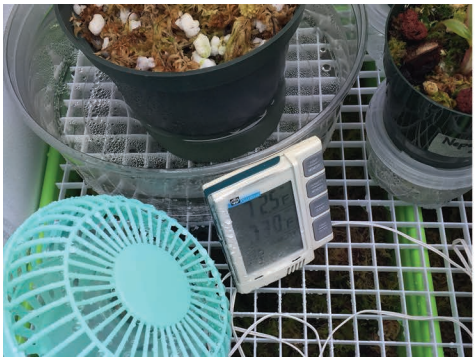


Figure 3: The completed chamber. A $4 USB fan circulates the air and prevents moisture accumulating on the foliage.

This was an interesting project and can easily be adapted to keep plants that are warm temperate species chilled, but not frozen, for dormancy, force orchids and bulbs into bloom, grow alpine species in warm areas, create warmer environments for desert plants, and even to augment husbandry of exotic reptile and amphibians. The downside to this project is that although my plants are slow growers, in 3-5 years I will either need a new set-up or several more freezers to accommodate their growth. By then, I hope to have a greenhouse with more cooling options available.