Waiting to Exhale

By Tom Gatz

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"Let's get this over with," lamented a 10-yeara-old boy as he and his parents waited in the Desert Botanical Garden's tour gathering area for my tour to begin on an otherwise perfect Sunday morning last winter. Thinking to myself that this could be a long 40 minutes, I reached back to my volunteer training and remembered: try to find something about the desert with which this young city-dweller can relate. While the tour group gathered, I learned that he really liked to swim, so I asked, "How long can you hold your breath underwater?" "For almost a full minute!" he proudly boasted. "That's pretty darn good," I replied, "but see that saguaro cactus over there? It can hold its breath all day long." When he asked me why it does that, I sensed that his curiosity about our desert plants was perhaps growing. By how the tour group had gathered around, and I explained that plants respire or "breathe" through tiny holes or pores (by taking in carbon dioxide and releasing oxygen through stomata). Doing so during the scorching heat of a summer day, however, would result in so much loss of moisture that cacti and most other succulent plants would eventually shrivel up and die. So, unlike most other plants, many cacti and succulents close their pores all day long and only "breathe" at night when things cool down. Concerned that I might lose my audience if I added too much more detail, I avoided mentioning that the technical term for this water-efficient type of photosynthesis is Crassulacean Acid Metabolism (CAM); I suspected that jaw-breaker would likely even cause the parents' eyes to glaze over. For those of you not prone to eye-glazing, please read on.

CAM photosynthesis also has practical applications for those of us who enjoy growing cacti and other succulents. Their need to "breathe" at night helps explain why some of our prize succulent specimens, usually the ones native to regions with summer nights cooler than ours, suddenly and seemingly inexplicably collapse and rot during our hot, humid monsoon season. It is likely that they are not dying from the heat of the day, but rather from the fact that nighttime temperatures no longer cool down enough for the plants to ever "wake up" to breathe and absorb carbon dioxide, especially here in the heat island of Phoenix. For CAM photosynthesis to work, a significant shift in temperature from day to night is required for the carbon dioxide to be stored (that's why CAM is rarely found in tropical succulents). Combine this state of semi-dormancy with monsoon rains for several days and you have a recipe for rotting plants. According to our Central Arizona Cactus and Succulent Society webpage, some of the plants most susceptible are many of the smaller cacti (hold off on watering them when the nights are above 90 degrees) as well as *Aeonium, Crassula, Dudleya, Echevaria, Sedum* and *Sempervivum.* Our website recommends bringing these rosette succulents into the house and keeping them dry all summer, resuming watering when night temperatures dip into the low 70's, usually right about now. Of course, an easier route is to stick with species native to the Sonoran Desert and let Mother Nature do most of the watering on her schedule.

Some cactus horticulturalists delay summer watering until late in the day, believing that cacti and succulents are better able to utilize water in the evening after their stomata open. However, Dr. Mark Dimmitt commented that, while evening watering is a good way to minimize water evaporation, active CAM plants can take up water whenever available, regardless of the time of day.

Interestingly, these night-breathing succulents store enough carbon dioxide as an acid during the night that they actually taste sour in the morning. By the afternoon, most of the acid has been used for photosynthesis and the plants taste bland. But be careful; many succulents are toxic. *Alluaudia* is a safe one to try if you want to conduct a "taste test" at home.

Some species (sedums, mesembs, and kalanchoes, for example) use "normal" photosynthesis (absorbing carbon dioxide during the day) to maximize growth during the winter, but switch to the less energy efficient CAM during summer to survive, giving them a huge growth advantage over their non-switching neighbors. Some plants have normal photosynthesis in their leaves and CAM on the stems (some *Euphorbia* species). Still others (mesembs, some agaves) start out as seedlings with normal photosynthesis then switch to CAM later in life when they first encounter water stress. Some agaves can switch back and forth between normal photosynthesis and CAM depending on water abundance.

When water-stressed, cacti and other succulents can "idle" by sloughing off fine roots and limiting respiration to moist internal tissues. Just like an idling engine, however, they can quickly rev up and resume full growth (if nighttime temperatures drop enough), often within 24 hours after a rain, giving them an advantage over dormant non-CAM leafy plants.

Pretty amazing, these desert plants. Even a 10-year-old boy might agree.

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