deficient in culture. Thus there is no food store restoration and the existing tubers are eventually exhausted.

MR. KUSAKABE also notes difficulty with the Australian tuberous Droseras in culture: "We have had a bitter experience trying to cultivate tuberous Drosera. We have difficulty in finding ways to propagate these plants without seeds. It is then necessary for us to find a method of non-sexual propagation. These tubers are actually a subterranean stem similar to the potato. Therefore, I am chopping the tuber of D. peltata and covering it with Sphagnum moss. Now, I'm keeping an eye on the pot and I hope for good results."

LEO SONG feels that growth temperatures are important in managing these species: "With regards to the tuberous Drosera problem, I'm trying the D. auriculata outside under lath. Since this species is also found in New Zealand, I think they would do better under cooler conditions since most of these types of Drosera grow during the cooler part of the year. The problem you seem to have with a gradual diminution in size with each passing year seems to be one where they are grown at high temperatures which increases the respiration rate and probably decreasing the rate of photosynthesis. At cooler temperatures, they respire less and may be in a more favorable range of temperatures for maximum photosynthesis resulting in more accumulation of carbohydrate which would be necessary for proper tuber formation. You might try growing the tuberous forms you now have at lower temperatures during the fall-spring season, protecting only against freezing, then letting them go dormant as summer approaches, watering only enough to prevent the tubers from totally drying out. Too much summer watering will most likely result in rotting since these plants seem to be adapted to being dry during the warmer months."

BOB BYE is currently in Chihuahua, Mexico doing extensive field work of ethnobotanical nature. He has seen Pinguiculas and is trying to relocate Utricularia livida which is described from both Africa and eastern Mexico.

## SHORT NOTES

### ASEPTIC SEED GERMINATION IN CARNIVOROUS PLANTS
by Warren P. Stoutamire

Terrestrial orchids have been grown from seeds at the University of Akron, using most of the standard techniques used for raising the commercial tropical epiphytes. These methods also work for many carnivorous plants and there are some advantages to keeping slow-growing species groups, such as Sarracenia, on sterile nutrient agar for several months. The greenhouse problems resulting from pathogens, watering problems, temperature problems, and insect pests are largely eliminated. We have successfully grown seedlings of species in the genera Sarracenia,

Darlingtonia, Heliamphora, Drosera, Utricularia, Byblis, Nepenthes and Pinguicula on sterile nutrient agar and find the procedures useful for our purposes. Speculation as to the causes of germination failure is reduced if the seeds are placed in an aseptic and highly visible environment. One knows after a suitable period whether the seeds are viable or not, there being no question of pathogens having eliminated them.

We routinely use a modified Knudson C agar, in which the following are placed in one liter of distilled water: monopotassium acid phosphate 0.25 gm; calcium nitrate 1.00 gm; ammonium sulfate 0.50 gm; magnesium sulfate 0.25 gm; ferrous sulfate 0.025 gm; manganese sulfate 0.0075 gm; sucrose 20.00 gm. and agar 8 gm. The agar-sugar-mineral mixture is slowly heated with constant stirring to near boiling to dissolve the agar. Failure to stir can result in scorched agar on the bottom of the container. Twenty-five milliliters of the hot solution is then poured into 100 cc square bottles, this amount producing an agar layer 1/4 inch deep when the bottles are placed on their sides after autoclaving. Any heat-resistant glassware will serve, so long as it can be plugged with sterile cotton plugs or rubber stoppers having a hole (also plugged with cotton) for pressure release during autoclaving. We use one-hole rubber stoppers in which a short length of glass tubing is inserted, a small cotton plug inserted into this tube. The projecting tube serves as a convenient handle when transferring seeds or seedlings.The bottles are steam sterilized at 15 lbs. pressure for 20 minutes, removed from the autoclave and placed on their sides to cool and harden. They are then ready for planting. The final pH will vary but is not critical for these plants.

Seeds are placed in small stoppered vials and covered to several times their depth with a calcium hypochlorite solution (10 gm in 140 cc water) which has been filtered to remove the insoluble suspended material. The vials are shaken for 20 minutes to continually wash seed surfaces with the hypochlorite solution. Vials are then carefully opened using aseptic technique and the surface-sterilized seeds are removed with flamed bacteriological wire loops and carefully placed on the sterile surface of the agar. Some familiarity with bacteriological technique is assumed at this point. Anyone who has grown orchid seeds on one of these standard agar media will have little difficulty handling seeds of insectivorous plants. The bottles are labeled, placed in diffuse daylight on a window sill or under fluorescent lights (we use daylight white tubes six inches above the bottles, light values being around 250 foot-candles at the bottle surface).

The bottles should be examined daily for 10 - 14 days, to check for contaminants which entered during the seed transfer or which were inside the seed coat and grew out into the medium. Sarracenia seeds are especially prone to fungal contamination because of the presence of these organisms under the seed coats during transfer. When fine filaments are seen growing out of any seed the entire seed and supporting agar may be lifted out with a sterile loop or the uncontaminated seeds

may be transferred to a fresh bottle. Usually only a few seeds are contaminated in any bottle but these must be removed or transferred when contaminants appear.

Germination time varies with species, Sarracenias and some Droseras appearing within four to six weeks of sowing. Drosera rotundifolia seeds will not germinate unless seeds are refrigerated in the flasks for several weeks. Byblis gigantea seeds may require a year before germination begins. Some tuberous Australian Droseras germinate quickly and grow prodigiously in bottles, especially D. auriculata and D. peltata. They will flower in flask if not removed in time. Drosera pygmaea and Pinguicula lusitanica also flower in flask. Other Drosera species either germinate irregularly or not at all, such as D. gigantea, D. macrophylla and D. stenopetala. It would be very informative to relate seed germination behaviour to ecology in some of these species of specialized habitats.

Seeds which have grown well in flask are ultimately transferred to the greenhouse and grown to maturity. We find these procedures useful, the seedlings requiring much less attention than their pot-grown equivalents in the greenhouse. The initial trouble of media preparation and planting is offset by the months of freedom from greenhouse work which follow. I would be interested in hearing the experiences of others in using specialized approaches to seed germination of these or other insectivores.

## GROWING ALDROVANDA VESICULOSA
by Tsunewo Saito

Aldrovanda vesiculosa loves acid (pH around 6) and fresh water, the same as other aquatic carnivorous plants such as Utricularia. The shape of the shoot apex of this species may tell you whether or not it is in healthy condition. Thus, if the shoot apex is rounded and onion bulb-shaped, it is in quite good condition in the right pH and environment. This species loves sunshine or high light intensity. Since you may be cultivating this species in small containers, water movement wouldn't be expected and you must watch the temperature in the container under sunlight. They do not like temperatures up to 32° C. (90° F.). The container must be earthenware instead of glass or metal. The best water temperature for Aldrovanda vesiculosa may be 25 to 30° C. where most flowering occurs. Acidity is very important for the cultivation of this species. You may put dead stems or leaves of grasses or sedges (especially rice grasses) in the water used for cultivation of Aldrovanda vesiculosa to promote acidity. Whenever the water color changes to yellow, it is a sign that the water is acid. If you have a pond with aquatic plants, like Japanese Iris, rushes, sagittaria, etc., and keep the water acid and abundant with organic compounds, it might be great to use it for Aldrovanda cultivation. If you use distilled water for Aldrovanda cultivation, you would have to add the following chemicals