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A Tale of Two Purslanes

By Dr. Peter A. Bowler, UCI Arboretum and Herbarium Director

Common purslane (*Portulaca oleracea* in the Portulacaceae, or Purslane Family) is a much appreciated, weedy, but also widely cultivated edible plant. It is an annual with a spreading or prostrate appearance that grows in disturbed areas and is “probably native to the Eastern hemisphere (but is) widely naturalized elsewhere (Baldwin, et al., 2012). It produces minute yellow flowers from April through October (*fide* the Jepson Manual) and has many common names, including common purslane, verdolaga, pigweed, little hogweed, and pursley.

Presumably because of their similarity in habit and general appearance, western sea-purslane (*Sesuvium verrucosum* in the Aizoaceae, the Fig-marigold or Ice-

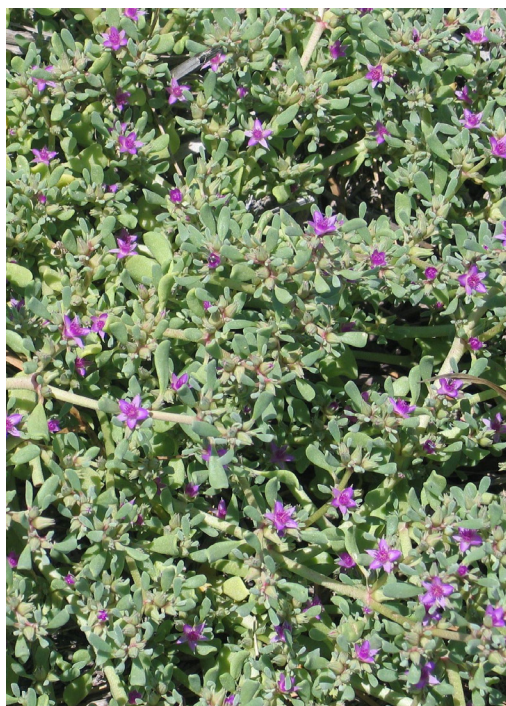
plant Family) shares a common name with its unrelated botanic look-alike. Many species of iceplant, such as crystalline iceplant (*Mesembryanthemum crystallinum*), are edible, and western sea-purslane is no exception.

Common purslane carpets the paths in our growing areas at the Arboretum, and is conspicuous elsewhere in pavement and sidewalk cracks as a prostrate, circular mat. It is easy to grow from cuttings, and clippings can yield an excellent addition to a salad. Both species can be used as a condiment, in salads, soups, or as a steamed vegetable, and their leaves, stems and flowers and flowers are edible. Both species have succulent leaves.

While common purslane is a weedy plant that can grow well in almost all conditions, western sea-purslane is a local native that occurs in salty soil habitats such as seasonally dry flats or along salt marsh margins.

At the UC Natural Reserve System’s San Joaquin Marsh Reserve it becomes a dominant halophyte on the pond bottoms or edges as they become dry in the late summer. Its vibrant purple flowers attract Lycaenid butterflies, especially the marine blue butterfly, and many other native pollinators.

It is a pleasure to try both purslanes, side by side, but western sea-purslane is best if it is harvested from shady areas, where it tends to be larger-leaved, somewhat etiolated, and is not as salty as plants in the direct sun. Soaking it in fresh water and rinsing it well before cooking helps remove



Western sea-purslane
Sesuvium verrucosum



Common purslane
(*Portulaca oleracea*)

Continued on page 8



Organic Decomposition and the Effects of Ultraviolet Light

By Nameer Baker, Graduate Student, Department of Ecology and Evolutionary Biology, UCI

The study that we are currently running at the UCI Arboretum is a decomposition experiment investigating the mechanisms that drive dry season decomposition of plant matter in Mediterranean climates. During decomposition, carbon compounds that make up plant material are broken down by microbes and abiotic factors into carbon dioxide, which is then released back into the atmosphere. As one can readily imagine, this carbon dioxide flux has become the focus of much research as the scientific community seeks to understand exactly how humans are altering the carbon cycle and other aspects of global ecology. We are choosing to focus on decomposition in arid and semiarid ecosystems (such as the Mediterranean climate of Orange County), because decomposition in these systems is consistently underestimated by traditional decomposition models. These traditional models were developed in mesic (more moist) ecosystems, leading us to believe that there are unaccounted-for factors in drier ecosystems that lead to this underestimation of decomposition rates.

Traditional decomposition models have three primary parameters: the average temperature of the

very low decomposition rates in dry ecosystems, although field studies have been able to show that actual decomposition significantly exceeds predicted rates.

There are two primary factors that have been hypothesized to take on added importance for dry season decomposition and may account for the greater than expected decomposition rates observed by field studies. The first is the photodegradation of aromatic carbon compounds such as lignin by ultraviolet radiation. During the dry season, plants senesce, removing chlorophyll and nutrients from their leaves and stems in order to reduce the cost of surviving through this period of high temperatures and minimal precipitation. As a result, there is an abundance of standing plant litter that is highly exposed to ultraviolet radiation after senescence. This ultraviolet radiation is thought to preferentially break down complex carbon compounds such as lignin which contain aromatic rings. This is of special note because lignin-like compounds are traditionally thought to be difficult for decomposer microbes to break down, due to their non-uniform structure and high molecular weight.

The second factor thought to take on added importance for dry season decomposition is the potential for increased overnight humidity to facilitate microbial decomposition. As stated earlier, precipitation in the dry

season is thought to fall below the threshold required for microbial decomposition of plant matter to be possible. However, precipitation measurements fail to take into account the significantly greater humidity present at night in Mediterranean ecosystems. It is thought that once the relative humidity of the atmosphere exceeds 75% that the air becomes moist enough to facilitate microbial activity, and summer nights in Orange County consistently exceed 75% relative humidity for hours at a time. For this reason, it is possible that microbial decomposition

is occurring throughout the dry season, despite the fact that soil moisture (as measured by precipitation) remains at a very low level through this period.

Our study seeks to determine the relative effects of these two drivers by excluding ultraviolet radiation from a set of litterbags while allowing ambient radiation to fall on a set of control litterbags. Our ultraviolet-



region in question, the amount of precipitation that the region receives, and the quality of the litter that plants provide to microbial decomposers. In general, decomposition rates increase with higher temperatures, greater precipitation, and higher litter quality. However, in drier ecosystems, reduced precipitation often results in soil moisture falling below what is considered to be the threshold for supporting microbial decomposition. As a result, traditional decomposition models predict

Continued on Page 8



Arboretum Holiday and Event Calendar early 2013

Friday, March 29
Arboretum closed
Cesar Chavez Holiday

Spring Perennial Sale
May 4 9 a.m. to 4 p.m.
May 5 11 a.m. to 3p.m.

April Showers of Flowers

April 13
9 a.m. to 4 p.m.



June Gloom? No, June Bloom!
June Bloom Plant Sale
June 15 9 a.m. to 3 p.m.

UCI Arboretum presents our next

Saturday Plant Sale

March 23 9 a.m. to 3 p.m.

Choose from spring perennials, succulents,
blooming bulbs from our nursery

Many unique and easy to grow items for
your garden

Expert advice on selection and care

Free admission and parking

For more information please call (949) 824-5833
or visit <http://arboretum.bio.uci.edu/>





A Year of Bulbs: The Fall

By Laura Lyons, Nursery Manager, UCI Arboretum

There is a yearly race to get the last bulbs repotted. We need to remove any remaining dead foliage, rearrange the bulb house, and cover the bulbs with wire mesh to keep out the critters that think the bulbs make tasty winter meals. Winter bulbs will break dormancy and sprout when the cool California winter nights arrive, sometime between September and December. With a little luck and hard work, repotting and preparing is complete by the beginning of winter so that we can begin watering at the same time. Appropriate winter watering ensures that the first sprouts are larger and stronger. This year, however, the lingering summer heat allowed us to prepare for the growing season at a more luxurious pace. In addition to our regular tasks, we had the leisure to rearrange the benches to give us more space and easier access to the bulbs. We even had the time to thoroughly reorganize the pots and spend a couple hours tidying the house and reorganizing supplies. Then, in the blink of an eye, we shot from summer into winter with just a nod at fall. Our winter bulbs, you see, need three things to sprout. First, they need cool night temperatures (at

or below 60°F); second, they need water; and, finally, they need a declining photoperiod. After a scant week of sixty degree overnight temperatures we plunged down to below fifty degrees and even had frost warnings! That woke the bulbs up in a hurry. However, there were still California native bulbs to repot. Native bulbs break dormancy about a month behind the South African winter bulbs. Our native bulbs sprout around December 1 because they need a more prolonged exposure to colder night temperatures to get them growing.

At the Arboretum, most of our potted bulbs are on a three-year repotting schedule. A handful of genera, like *Babiana*, are such vigorous growers that they need to be repotted every two years. Additionally, rapidly growing seedling bulbs often need repotting every year or two to prevent overcrowding in the pots. Repotting seedling bulbs more often than every three years is particularly necessary if the seeds were sown very densely, as I prefer to do. Space in the Arboretum bulb house is at an eternal premium and we have to accommodate a very large collection of growing bulbs. Still, for the bulk of our collection, and for most potted bulbs at home, repotting once every three years is a perfect schedule. While certain genera, such as *Babiana*, sprout first, others, like *Nerine*, inevitably lag behind, but newly repotted bulbs always are the first and strongest to sprout.

A good system that we use at the Arboretum, and one that you can easily replicate at home, is to coordinate your yearly repotting schedule with colored tags. When we repot our bulbs, the new pots are marked with a colored tag denoting the year. We purchase colored plant tags, much like the common white ones, from a nursery supplier and put them next to the white tag. This year, our color was, appropriately enough, green.

Once we have all the bulbs repotted and prepared for winter, we begin sowing seeds, one of my favorite times of the fall. Throughout



Freshly repotted *Lachenalia mutabilis* in foreground show much more vigorous growth than the older pots from 2010 in the background.

Continued on Page 5



the previous winter and spring we collect seeds from seed-bearing structures, extract the seeds, prepare pots and trays, and get busy. The students even pitched in to clear a space on the sprinkler bench, where I prefer to start my young seedlings because the gentle water from the sprinklers is less likely to wash away vulnerable seeds. These small but invaluable contributions that our students and volunteers make are so deeply appreciated. There are always some bulbs of which we have too many to repot. Some of them are returned to the bulb house, but many move on to happy new homes with our volunteers.



Young bulbs sprouting in the bulb house. The wire mesh protects against rodents eating tender bulbs.

It's important to remember that appropriate watering is essential as bulbs sprout. By the time the first sprout appears, the roots are already well developed underground or in the pot. However, both the roots and the bulbs are highly susceptible to rot at the early stage during the growing season. A bulb's vulnerability to rot is particularly high if daytime temperatures are warm. Therefore, it is important to keep the soil evenly damp, but not soaking wet. If nature provides rain in the late fall and early winter, so much the better; bulbs respond well to rainfall as long as they are not constantly drenched.

At the Arboretum, once the South African bulbs are well up and growing, usually just after the new year, it is time to consider fertilizing them. Bulbs require low nitrogen so choose your fertilizer carefully. When fertilizing your bulbs, avoid most "bulb fertilizers" if bone meal is a dominant ingredient. Modern bone meal is highly processed and contains no nitrogen to support the plant's growth. Our grandparents fertilized their bulbs with an amendment that had nitrogen in abundance

such as "blood-and-bone," Instead of using a common "bone meal" fertilizer. However, we have a broader range of choices today and you can choose a low nitrogen fertilizer. You can purchase either a ready to use low-nitrogen fertilizer, like Gro-Power, or you can use one of the fertilizers that are diluted in water, like Miracle-Gro.

If you use a fertilizer that needs to be diluted in water, you can prepare it using a weaker concentration than that suggested in the package directions. Another good option for bulbs is using an organic fertilizer, with its naturally low nitrogen. Generally, you should aim for about five to seven percent nitrogen in your final mix. For example, if you're using Miracle-Gro, preparing it at a quarter the package strength gives you about five percent nitrogen. At the Arboretum we often use Gro-Power Plus granular (5-3-1) to fertilize the bulbs, but I also occasionally use a 14-14-14 liquid prepared at half strength. We fertilize California native bulbs very sparingly, perhaps once a season, with an even lower nitrogen content fertilizer. For instance, we fertilize California bulbs with half the normal amount of Gro-Power Plus, or we prepare the liquid fertilizer at quarter strength.

In the end, bulbs repay us for all of our hard work, patience, and effort. The rewards come swiftly as *Nerines*, *Strumerias*, and *Brunsvigias* stage their pre-season bloom in October and November. They are swiftly followed by the odd early season bloomers such as *Watsonia hysternantha* and *Massonia echinata*. With the South African bulbs sprouting and the California natives not far behind, we know that the best is yet to come.



Massonia depressa blooming in early December.



Biofuel Research at UCI

By Quentin Dietz, Elaine Ngo, Monil Patel, Sandy Ortiz, Sharango Kundu, Jahanzeb Ashraf, Andrew Dugum, Richard Truong, Bertha Mok, Christine Vu, and Ellaine Talle, Undergraduates, UC Irvine

As the world is quickly becoming aware, nonrenewable fuel resources are being utilized at unsustainable levels. Although natural gas and oil have been the world's primary source of energy for decades, they are becoming depleted. For this reason an active interest in alternative fuels has arisen. However, the recent surge in alternative fuel research has not yet demonstrated a suitable replacement for traditional energy sources. Hydrogen, for example, is difficult to synthesize and store, solar energy is expensive and inconsistent in energy delivery, and electric car batteries are costly. Considering these factors, our primary research objective is the implementation and perfection of a method of growing and extracting biofuel from algae to create an economically attractive and sustainable replacement for petroleum-based fuels.

In order to achieve the goal of finding a cost efficient solution to the production of oil from algae our research is divided into four different parts: growth, drying, extracting and measuring.

The growth process is a delicate stage in which we strive to grow our algae in the most cost efficient way while maintaining it free of contamination. In order to achieve this we have set up the algae in artificially lighted tanks supplied with a constant stream of CO₂. The positioning of the circulated CO₂ bubbles and the monitored day/night cycle are things that are crucial to the successful growth of the algae. Another important factor in the growth of the algae are the nutrients used and the quantity in which they are given to the algae. Indeed, nutrients are one of the most costly parts of the production process and therefore getting the most efficiency in this stage is crucial. We are raising several strains of unicellular green algae that have shown the most promise in commercial biofuel applications.

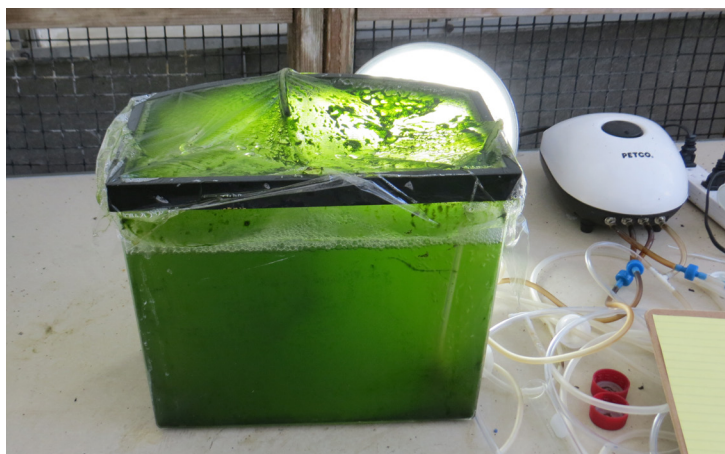
Drying freshwater algae is an important precursor to the process of extraction. Without the proper drying techniques, the algae will not be an adequate source for their oil, which is the basis of algal biofuel production.

Though there are different techniques that can be used during this process, the most cost effective method

would be to use natural sunlight. For this reason, this is the method we have been testing to dry the algae. By setting the algae and freshwater mixture outside in a Petri dish covered with plastic wrap in an area where sunlight is prevalent, we have been able to experiment with variable times and outside temperatures in order to see what factors are ideal for proper drying and extraction processes. Without proper drying techniques, extraction of any sort of oil would not be possible.

Extraction is the process of isolating the hydrocarbons needed for oil from the algae. This is an integral step in making fuel. If certain compounds are not isolated, the solution is diluted with too many by-products that can lead to skewed results. The different methods of extraction include simple liquid-liquid extraction, in which different chemicals are added to separate the compounds of interest by densities and masses. This includes partitioning and acid-base extractions. Due to limited resources, the team has chosen to utilize simple extractions with simple liquids such as different solutions of salts and hydrogen peroxide. Although some oil-like compounds have been extracted, these amounts are very minimal. In the future, we hope to use more efficient chemicals such as dichloromethane, DBU-octanol and hexane, which in literature, have shown better results.

The measurement portion of our research is crucial in finding the most cost efficient way to grow, dry and extract algae. Currently there is no simple way to measure the quantity of algae present in a tank. However, we have taken a new approach in measuring this quantity using light density in order to correlate it with a growth rate. Having accurate and constant measurements allow us to evaluate our experiments in a precise manner and helps us find the most cost efficient solution to creating biofuel.





Weeding in a Winter Wonderland!

By Dr. Peter A. Bowler, UCI Arboretum and Herbarium Director

As the days shorten with the approach of winter solstice, the weeds of the spring and summer seem forgotten. But, in reality, even the small rains of the fall trigger germination in seasonally dormant seeds both at the Arboretum and in the adjacent San Joaquin Marsh Reserve. In the Arboretum some of our primary weeds include bristly ox-tongue (*Helminthotheca echioides*), telegraph weed (*Heterotheca grandiflora*), horseweed (*Conyza canadensis*), Spanish sunflower (*Pulicaria paludosa*) and scarlet pimpernel (*Anagallis arvensis*), among many more. In the Arboretum's research area controlling diffuse knapweed (*Centaurea diffusa*) is an ongoing challenge. Some of our deliberately planted species are weedy and require containment as well. But the onset of late fall and winter precipitation triggers germination in all of these weedy taxa.



In the Marsh and especially in the 150-foot buffer zone of uplands surrounding it, artichoke (pictured above) (*Cynara cardunculus*), annual European brome grasses, black mustard (*Brassica nigra*), and fennel (*Foeniculum vulgare*) are abundant. In the wetlands castor bean (*Ricinus communis*), poison hemlock (photo to the right) (*Conium maculatum*), Swiss chard and beets, and *Bassia hyssopifolia*, are prominent among the problem plants. In recent years

Spanish sunflower (*Pulicaria paludosa*) and bristly ox-tongue have increased in presence along the pond margins. Although the vascular plant species actually within the area of water inundation are almost all natives, nearly fifty percent of the total Marsh flora is non-native – with exotics primarily occurring on the dikes, levees and in the surrounding uplands along the Marsh periphery (Bowler and Elvin, 2003).

In both the Arboretum and the Marsh, students and volunteers contribute to controlling these invasives by weeding young plants, uprooting them, and ultimately eliminating them. Weeding begins at germination and continues until the annual invasives die or the perennial problem plants retreat into seasonal dormancy. The California Invasive Plant Council (Cal-IPC; see www.cal-ipc.org/) and the Center for Invasive Species Research (<http://cisir.ucr.edu/>) are excellent resources for identifying and recommending control techniques for weedy species.

Controlling exotics comprises a small subset of the extensive academic use supported by both sites. The Arboretum is the convening arena for nearly all Marsh use, and a tour of our gardens is the universal introduction to the wetlands beyond. Thus, use of the Marsh is shared with the Arboretum in a complementary way. During the past academic year there were sixteen class titles that reported visits to the Marsh Reserve by way of the Arboretum – some with many sectional offerings, many with multiple uses, and several Independent Study titles with on-going enrollees each quarter. Eleven universities and colleges from California, four outside of California, two international institutions, one K-12





school, and seven UCI programs used the Marsh through its Arboretum interface for a total of 3,946 user days. The Horticultural Science (Bio. 9E) class that holds its laboratory sessions in the Arboretum had its usual strong enrollment (55 students), and there were 41 students in our Horticultural Practices (Bio. 197) class.

The dovetailing of the academic and research relationships between the Marsh and the Arboretum continues to flourish – whether in mutual seasonal weeding or as a gateway to shared beneficial educational resources. Thus, as the winter rains and increasing daylength of the spring bring new life, the promise of the New Year begins! In the Marsh the sprouting of cattails,

new coastal bulrush stems, and the early nesting of resident and some migratory species are underway – and at the Arboretum, we are preparing for winter planting.

References

Bowler, P.A. and M.E. Elvin. 2003. The vascular plant checklist for the University of California Natural Reserve System's San Joaquin Freshwater Marsh Reserve. *Crossosoma* 29(2): 45-66.

California Invasive Plant Council (Cal-IPC) <http://www.cal-ipc.org/>
Center for Invasive Species Research (<http://cistr.ucr.edu/>)

Organic Decomposition and the Effects of UV Light, Continued

blocking treatments will therefore solely be subjected to humidity-facilitated microbial decomposition overnight, whereas our ambient treatments will also be subjected to ultraviolet photodegradation. In order to determine whether ultraviolet radiation preferentially degrades lignin, half of our litterbags contain litter from a grass with low lignin content, while the other half contain grass litter that has a higher lignin content. By performing analyses on litter chemistry after our experiment, we hope to determine how initial chemical content (such as percent-lignin) will affect the rates of mass loss under our ambient and ultraviolet-blocking treatments. We expect that higher lignin litter will decompose more slowly when ultraviolet radiation is blocked, as high lignin content inhibits traditional microbial decomposition. In addition, we will also be looking to see if ultraviolet

photodegradation of lignin-like compounds results in more simple compounds being available for microbial decomposition. This hypothesized “priming” effect has yet to be observed in field studies, but if present it may result in dry season photodegradation priming plant litter for increased wet season decomposition. We hypothesize that this process will manifest itself in decreased wet season decomposition in our ultraviolet-blocking plots. Our hope is that the results from this experiment will enable us to develop a model of dry season decomposition that can be used to accurately forecast annual decomposition in a future that will be marked by altered seasonally lengths and increased aridity of summer months, something that is currently lacking in the ecological community.

A Tale of Two Purslanes, Continued

the saltiness when eaten raw. But both are a refreshing taste of our local flora – exotic and native alike.

Here are a few links to recipes, cuisine images, and other information about our two purslanes:

<http://www.prairielandc-sa.org/recipes/purslane.html>

http://www.menshealth.com/mhlists/best_healthy_foods/Purslane.php

<http://www.greensandseeds.com/purslane-soup-with-herbed-potatoes/>

<http://www.google.com/search?q=purslane+recipes&hl=en&client=safari&rls=en&prmd=imvnse&tbn=isch&tbo=u&source=univ&sa=X&ei=DJlfULy3JMifiQLYpID>

[YBQ&sqi=2&ved=0CCgQsAQ&biw=1404&bih=524](http://www.jepsonmanual.org/YBQ&sqi=2&ved=0CCgQsAQ&biw=1404&bih=524)

Technical descriptions from the 2012 edition of the Jepson Manual:

http://ucjeps.berkeley.edu/cgi-bin/get_IJM.pl?tid=44236

http://ucjeps.berkeley.edu/cgi-bin/get_JM_treatment.pl?6318,6390,6392

References

Baldwin, B.G., D.H. Goldman, D.J. Keil, R. Patterson, T.J. Rosatti, and D.H. Wilken, editors, 2012. The Jepson Manual: Vascular Plants of California (Second Edition). University of California Press, Berkeley.