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Department of Environmental Horticulture • *University of California, Davis*

GROWING Points

Tolerance of Landscape Plants to Recycled Water Irrigation

By Lin Wu, professor, Xun Guo (postgraduate researcher) and Kimberely Hunter (research assistant) of the Department of Environmental Horticulture, UC Davis; Ellen Zagory, nursery manager for the **UC Davis Arboretum***; Roger Waters of the* **Marin Municipal Water District***, Corte Madera, CA; and Jerry Brown of* **South Bay Water Recycling***, San Jose, CA.*

Due to California's rapid population growth, the competition for increasingly limited water resources has necessitated the use of reclaimed or recycled water for landscape and nursery irrigation. Reclaimed or recycled water is water that has been previously used, suffered a loss in quality and has been treated to a point where it is suitable for additional use. The first wastewater treatment plant used solely for recycling water was built in San Francisco in 1932. Today, wastewater is recycled at over 300 locations throughout California for agricultural and landscape irrigation, groundwater recharge and industrial use. The **California Water Resources Control Board** estimates that by the year 2010, landscape irrigation will account for the second largest use of recycled water next to groundwater recharge. After most water treatment processes, sodium chloride (NaCl) is the only chemical compound remaining in recycled water that is potentially detrimental to landscape plants. Other elements such as boron, selenium, magnesium, and cadmium are rarely found to be above harmful levels.

Experimental layout for salt tolerance screening of landscape plants.

The long-term tolerance of many plant species commonly used in California landscapes to such water is not widely known. The objective of this research project, funded by the **Elvenia J. Slosson Endowment**, was to conduct screening trials on a large number of landscape plant species to determine their tolerance to NaCl in irrigation water at concentrations commonly found in recycled water. Both sprinkler and drip irrigation systems were used to compare plant performance under these two different application methods. A reference list of the tolerance of plant species to recycled water based on growth reduction relative to control plants was generated (page 7) and may be useful in the implementation of recycled water irrigation programs.

Species used and planting methods

In all, 38 woody landscape species and 10 California native grass species were tested (see page 7). Selection of plants was based on both the popularity of the species in California landscapes and the inclusion of a wide range of growth habits. The California native grass species included in the study were chosen for their potential as ornamentals and/or for creating buffer zones between landscapes and watersheds. Plants were planted or set out in containers in field plots (see photo). Overhead sprinklers or drip emitters were used to apply one inch of water every other day during the dry season from May to November. Plants relied on rainfall from December to April. Slow-release fertilizer was applied twice during the growing season. Liquid fertilizer injectors were used to deliver salt treatment solutions into the irrigation water.

Irrigation treatments

The chemical analysis of recycled water reported by the Marin Municipal Water District (MMWD), Corte Madera, California for 1993 and 1995 and the water treatment facility of the City of San Jose, California in 1996 and 1997 indicated NaCl to be the principal compound remaining after treatment that might be detrimental to plants. The average sodium (Na) concentrations ranged from 156 ppm (parts per million) to 225 ppm. Chloride (Cl) concentrations averaged from 175 ppm to 319 ppm. Based on this information, three irrigation treatments were selected for the experiment- control (potable

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The Discovery of Dawn Redwood

by Michael Barbour and Valerie Whitworth

Editor's note: The following is an excerpt from a new book entitled *Coast Redwood: A Natural and Cultural History*, edited by John Evarts and Marjorie Popper and published by Cachuma Press. A diverse group of authors, including Michael Barbour and his wife, Valerie Whitworth, have combined their efforts to present a fresh and comprehensive look at *Sequoia sempervirens* as a key component of a unique forest ecosystem and as a commodity in human society whose demand far exceeds its supply. This richly illustrated book documents the origin and life history of the coast redwood and describes the plants and wildlife that depend on the habitat it has created. The development of redwood logging and subsequent struggle for preservation are chronicled from the 19th century to the present-day. Current management issues in redwood parks and timberlands are explored with emphasis on the prognosis for sustainability of this magnificent species. *Coast Redwood: A Natural And Cultural History* can be ordered directly (with a 10% discount for *Growing Points* readers) from Cachuma Press, P.O. Box 560, Los Olivos, CA 93441 (**cachuma@silcom.com**). Reprinted with permission. Copyright Cachuma Press.

Dawn Redwood, Metasequoia glyptostroboides, in the UC Davis Arboretum

In the mid-nineteenth century, at about the same time that coast redwood was being named *Sequoia sempervirens*, the first fossil impressions of plants that resembled it were also being cataloged. These fossils were initially found in Europe, but others followed from North America and Asia. The plant fossils came from an enormous range of latitude and longitude throughout the temperate zone, even extending into polar latitudes. Some were assigned to extinct species of *Sequoia* (if the plants were evergreen) and some to extinct species of *Taxodium* (if deciduous). Paleobotanists found it difficult to explain how *Sequoia*, which is now restricted to a mild coastal climate, could have close ancestors that tolerated near-polar conditions. Ralph Chaney, a Professor of Paleobotany at the University of California, Berkeley, speculated that these early redwood species were genetically different from modern redwood-that they were ecotypes with a frost-tolerant physiology.

Just before the start of World War II, Japanese paleobotanist Shigeru Miki concluded that many of these fossils had been misinterpreted. Some of the extinct *Sequoia* and *Taxodium* species actually could be pooled together into a single genus, previously undescribed. This new genus had opposite branches and leaves, seed cones with opposite scales borne on long naked stalks, and deciduous leaves. From these fossils it became clear that a winter-deciduous relative of *Sequoia*, and not *Sequoia* itself, had once been common throughout the northern cold-temperate region of the world. Miki called this new extinct genus *Metasequoia*. He published his conclusions in the *Japanese Journal of Botany* in 1941.

Around the same time that Miki's article on the genus *Metasequoia* was published, a Chinese forester visiting the remote village of Modaoqi in central China came upon an interesting tree he could not identify. Researcher Tsang Wang sent samples from the tree to Dr. Wan Chun Cheng at the National Central University in Nanking in 1944. Cheng forwarded these specimens, along with additional ones collected by a colleague's assistant, to Dr. Hsen-Hsu Hu in Beijing. Hu was a friend and former student of UC Berkeley's Chaney. Hu corresponded with Chaney about the exciting discovery of what he believed were specimens from the supposedly extinct genus *Metasequoia* described in Miki's article. Hu also relayed some of the samples to Dr. Elmer D. Merrill at Harvard University's Arnold Arboretum.

Chaney remained skeptical about the possibility of living *Metaseqnoia* trees until January, 1948 when he received a packet from Hu. The day the package arrived, Milton Silverman, a science writer for the *San Francisco Chronicle*, was interviewing Chaney for a series of articles on paleobotany. According to Silverman's unpublished memoirs, Chaney opened the letter coated with Chinese stamps, and upon viewing the fresh, green, nonfossilized specimens, he fainted. When he revived, Chaney immediately began to plan a trip to China to view the *Metasequoia* trees for himself.

Silverman decided to accompany Chaney on his trip to report the story for the *San Francisco Chronicle*. Within a month, Chaney and Silverman were on their way to Modaoqi. Chaney's trip was sponsored by the **Save-the-Redwoods League**. Silverman was traveling on a budget of $2000 granted to him by the editor at the Chronicle who made a point of telling Silverman,"... if you don't find the damn trees, just keep on walking. Don't bother to come back." For his newspaper stories, Silverman needed a name for the tree which, at that point in time, was known only by its Latin name, *Metasequoia glyptostroboides*, a moniker too long to fit comfortably in most one-column headlines. The name he and his editors chose is the same one used today, dawn redwood.

When they reached China, Chaney and Silverman were joined by a group of Chinese foresters and guides. The group was able to fly as far as Chungking, where they boarded a steamer to Wanxian. From there they hiked over mountain trails for three days to reach the village. At the edge of the village stood one large *Metasequoia*- about 100 feet tall and 6 feet across at the base- and two smaller ones, 20 to 30 feet tall. It was March; all three stood leafless against the sky but their cones and old leaves carpeted the ground beneath them.

The local villagers called the trees *shui-hsu* ("water pine") because they were similar to the water pines of southern China (*Glyptostrobus pensilis* in the family Taxodiaceae). More trees had been found

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Student and Faculty Research Updates

Calorie counting for roses?

Using the techniques of microcalorimetry, it is possible to measure the metabolic heat given off by very small samples of plant tissue. With modifications, this system can also measure the energy used by the same sample in respiration. The balance of these two measurements represents the rate of storage of chemical energy in plant tissues and serves as an indicator of potential growth rate. **Dave Burger**, Heiner Lieth and Michael Raviv of Israel's Agricultural Research Organization used microcalorimetry to determine growth rates of cut-flower roses under different temperatures and in different growing media.

Breaking shoot buds showed maximum growth rates at low temperatures (10°C) contradicting the grower practice of raising temperatures after pinching to promote bud break. Young rose leaflets showed maximum growth rates near 25°C but these were affected by the degree of water stress in the growth media. At 25°C, plants growing in both coir (coconut fiber) and UC Mix (42% composted fir bark, 33% peat and 25% sand) showed optimal leaflet growth rates under conditions of no water stress (low moisture tensions, less than 5 kPa). With increasing water stress (higher moisture tension values) leaflet growth rates declined, reaching zero for UC Mix around 20 kPa. In the coir medium, however, leaflet growth rates declined but remained relatively high at 20 kPa, suggesting roses in this growth medium would perform better under conditions of water stress.

Cut flowers don't always like water

Ideally, long distance transport of cut flowers packed dry in pre-cooled boxes and held near 0°C during shipping results in high-quality flowers with maximum vase life for the consumer. The real world, however, is a far different place where time may not allow pre-cooling and transport vehicles may not have refrigeration, resulting in higher losses and poor quality flowers. The recent trend toward shipping cut flowers in upright, plastic containers with water has mediated some of these problems, despite the increased expense for transporting a heavier product. **Michael Reid** contends, however, that flower vase life is ultimately a function of respiration during transport and only holding flowers at the lowest possible temperature can control that respiration. He and Master's student Juan-Carlos Cevallos of Ecuador set out to compare the vase life of several cut flower species after storage (simulated transport) dry or in water at a variety of temperatures.

The vase life of all seven species studied decreased as storage temperature increased whether stored wet or dry. After storage temperatures above 10°C, flowers stored in water had longer vase lives than those stored dry, but were still significantly shorter than vase lives of flowers stored at lower temperatures. Wet storage at higher temperatures prevented desiccation but elevated respiration rates at those temperatures still resulted in shorter vase lives. Proper temperature management during shipping is the key to maximum vase life of cut flowers.

Decaying logs are essential for diversity of mosses and liverworts in Oregon forests

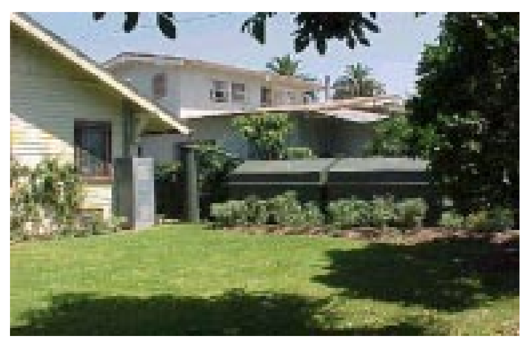
In 1990, only 13% of old growth forest remained in Oregon and Washington. The loss of this habitat has resulted in the decline of many associated species of plants and animals including bryophytes (mosses and liverworts). Federal mandates to protect those bryophyte species associated with old growth forest have prompted forest managers to encourage biodiversity in timber-producing stands. Tom Rambo, a Ph.D. student with Michael Barbour and **Malcolm North**, surveyed several forest plots from 50 to 200 years old, studying the various types of substrates that mosses and liverworts grow on including soil, rock, living plants and decaying logs. Information about which substrates support the most number of bryophyte species is essential for developing forest management guidelines to preserve biodiversity.

Rambo found the greatest diversity of bryophyte species growing on fallen logs in advanced stages of decay but also found many species dependent on disturbed soil and rock. He concluded that the retention of mature overstory trees in managed forest stands would ensure future treefall disturbance and a continual supply of decaying woody debris necessary to encourage biodiversity of mosses and liverworts.

Make your home a mini-watershed

In the United States, 80% of the population lives in metropolitan areas and on average, tree canopy from about 75 billion trees covers 33% of this land area. The impact of these urban forests on storm runoff is of growing interest as efforts to protect water quality focus on non-point pollution sources within urban watersheds.

Greg McPherson and the research staff of the **Western Center for Urban Forest Research** have joined forces with several groups including TreePeople (**www.treepeople.org**) to convert a Los Angeles residence into a "mini-watershed" that retains runoff on-site and stores roof runoff for landscape irrigation. At this home site, they hope to demonstrate Best Management Practices (BMPs) developed to address issues of water conservation, stormwater runoff mitigation, air-cooling energy cost reductions, air quality improvements, and green waste reduction. Policy makers are considering implementing this type of decentralized approach to urban watershed management, but lack quantitative data on the effectiveness of different BMPs. Objectives of the study include measuring hydrological processes at the residential site scale to quantify the effects of BMPs on runoff amounts and water quality, landscape water conservation, rainfall interception by vegetation, detention storage, and infiltration. GP



System for collecting and storing storm runoff from a residential roof.

Specification Guidelines for Container-Grown Landscape Trees

Taken from the web site: www.urbantree.org/specs.htm

After more than a year of work, a committee comprised of municipal arborists, urban foresters, nurserymen, U.C. Cooperative Extension horticultural advisors, landscape architects, non-profit tree groups, horticultural consultants, etc., developed the specifications below to ensure the production of high quality landscape trees. This document will be published and the guidelines promoted throughout the nursery and landscape industry. Its intent is to help landscape professionals develop their own comprehensive and detailed specifications to ensure that they obtain high quality container-grown nursery trees. Depending on species, intended use, and availability of the trees, some elements of these guidelines may need to be modified.

The quality of nursery stock can be greatly improved by applying a few simple, relatively inexpensive propagation techniques. Industry-wide adoption of the improved nursery practices, and adherence to recognized standards will help ensure quality container-grown trees.

Obviously it will take some time for wholesale nurseries to begin producing consistently high quality container-grown trees. It is imperative, though that landscape professionals start using guidelines to specify the quality and characteristics of trees they desire. This will demonstrate to the nursery industry that there is indeed a market for this product.

I.PROPER IDENTIFICATION

All trees shall be true to name as ordered or shown on the planting plans and shall be labeled individually or in groups by species and cultivar (where appropriate).

II.COMPLIANCE

All trees shall comply with federal and state laws and regulations requiring inspection for plant disease, pests and weeds. Inspection certificates required by law shall accompany each shipment of plants. Clearance from the County Agricultural Commissioner, if required, shall be obtained before planting trees originating outside the county in which they are to be planted. Even though trees may conform to county, state, and federal laws, the buyer may impose additional requirements.

III. TREE CHARACTERISTICS AT THE TIME OF SALE OR DELIVERY

A. Tree Health

As typical for the species/cultivar, trees shall be healthy and vigorous, as indicated by an inspection for the following:

1. foliar crown density
2. length of shoot growth (throughout crown)
3. size, color and appearance of leaves
4. uniform distribution of roots in the container medium
5. appearance of roots
6. absence of twig and/or branch dieback
7. relative freedom from insects and diseases

Note: some of these characteristics cannot be used to determine the health of deciduous trees during the dormant season.

B. Crown

1. Form: Trees shall have a symmetrical form as typical for the species/cultivar and growth form.

a)Central Leader: Trees shall have a single, relatively straight central leader and tapered trunk, free of codominant stems and vigorous, upright branches that compete with the central leader. Ordinarily, the central leader should not have been headed. However, in cases where the original leader has been headed, an upright branch at least ½ (one-half) the diameter of the original leader just below the pruning point shall be present. Note: This section applies to single trunk trees, as typically used for street or landscape planting. These specifications do not apply to plants that have been specifically trained in the nursery, e.g., topiary, espalier, multi-stem, clump, etc., or unique selections such as contorted varieties.

b) Main Branches (Scaffolds): Branches should be distributed radially around and vertically along the trunk, forming a generally symmetrical crown typical for the species. Minimum vertical spacing may be specified.

· Main branches, for the most part, shall be well spaced. (see photo above)

· Branch diameter shall be no larger than 2/3 (two thirds) the diameter of the trunk, measured 1" (one inch) above the branch.

· The attachment of scaffold branches shall be free of included bark.

This young tree has poor branch spacing. The leader is being choked out by vigorous upright laterals.

c)Temporary branches: Unless otherwise specified, small "temporary" branches should be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1-1/2" (one and one-half inches) in trunk diameter. Temporary branches should be distributed radially around and vertically along the lower trunk. They should be no greater than 3/8" (three-eighths inch) in diameter and no greater than ½ (one-half) the diameter of the trunk at the point of attachment. Heading of temporary branches is usually necessary to limit their growth.

C. Trunk

1. Trunk diameter and taper shall be sufficient so that the tree will remain vertical without the support of a nursery stake.

2. The trunk shall be free of wounds (except properly-made pruning cuts), sunburned areas, conks (fungal fruiting-bodies), wood cracks, bleeding areas, signs of boring insects, galls, cankers and/or lesions.

3. Trunk diameter at 6" (six inches) above the soil surface shall be within the diameter

range shown for each container size below:

Container Size	Trunk Diameter (in)
# 5	0.5" to 0.75"
# 15	0.75" to 1.5"
24-inch box	1.5" to 2.5"

D. Roots

1. The trunk, root collar (root crown) and large roots shall be free of circling and/or kinked roots. Soil removal near the root collar may be necessary to inspect for circling and/or kinked roots.

2. The tree shall be well rooted in the soil mix. When the container is removed, the rootball shall remain intact. When the trunk is carefully lifted both the trunk and root system shall move as one.

3. The upper-most roots or root collar shall be within 1" (one inch) above or below the soil surface.

4. The rootball periphery should be free of large circling and bottom-matted roots. The acceptable diameter of circling peripheral roots depends on species and size of rootball. The maximum acceptable size should be indicated for the species (if necessary).

E. Moisture Status

At time of inspection and delivery, the rootball shall be moist throughout, and the tree crown shall show no signs of moisture stress, as indicated by wilt, shriveled, dead leaves, or branch dieback. Roots shall show no signs of being subjected to excess soil moisture conditions, as indicated by root discoloration, distortion, death, or foul odor.

IV. INSPECTION

The buyer reserves the right to reject trees that do not meet specifications as set forth in these guidelines or as adopted by the buyer. If a particular defect or substandard element or characteristic can be easily corrected, appropriate remedies shall be required. If destructive inspection of rootballs is to be done, the buyer and seller should have a prior agreement as to the time and place of inspection; minimum number of trees to be inspected, or percentage of a species or cultivar, and financial responsibility for the inspected trees.

V. DELIVERY

The buyer should stipulate how many days prior to delivery that notification is needed. GP

Salt Tolerance Cont'd from page 1

water); low salt (500 ppm NaCl), and high salt (1500 ppm NaCl). The low salt treatment supplied 200 ppm Na and 300 ppm Cl, thus approximating the highest Na and Cl concentrations found in recycled waters. To insure a relatively higher salt stress, 1500 ppm NaCl was chosen which provided 600 ppm Na and 900 ppm Cl.

Evaluation of salt tolerance

Visual symptoms such as chlorosis and leaf burn were recorded as percentage of leaves affected, and were translated into salt tolerance indices (%) by subtracting from 100%. In addition, plant height and canopy diameter were measured after 6 weeks of salt treatment. A tolerance index was calculated as: Index of salt tolerance = (mean value of plant height plus canopy diameter of salt treated plants / mean value of plant height plus canopy diameter of control plants) x 100. Plant species were placed into three salt tolerance categories according to their tolerance indices (above 90% = High; above 50% less than 90% = Moderate; less than 50% = Low). In addition, leaf samples were collected and analyzed for Na and Cl content.

Results and Conclusions

All drip-irrigated plants exhibited normal growth with most showing no foliar symptoms of salt stress. Only chinese pistache and rose developed chlorosis in fewer than 10% of their leaves when drip-irrigated with water containing the high salt concentration. Tolerance of the various species to sprinkler irrigation with water containing low or high levels of salt is summarized in the table on page 7. Twelve (31%) of the 38 woody plant species and 5 (50%) of the 10 native grass species were salt tolerant when irrigated with 1500 ppm salt while 21 (55%) woody species and 7 (70%) native grass species were salt tolerant when irrigated with 500 ppm salt.

Plants irrigated with the low salt concentration (500 ppm) had 2 to 4 times more leaf tissue chloride than the controls. Leaf chloride concentrations of plants irrigated with high salt water (1500 ppm) were 4 to 5 times greater than those of plants irrigated with potable water. Plants irrigated with low salt water had 2 to 15 times more sodium in their leaves than the controls. Ten to 20 times more sodium was detected in leaf tissue of plants irrigated with the high salt concentration.

Most recycled waters contain less salt than the lower concentration (500 ppm) used in this study. Plant response under these experimental conditions should be indicative of plant salt tolerance in the landscape. Drip irrigation using recycled water was acceptable for nearly all the plant species used in this experiment. In California, however, sprinkler irrigation is used for most landscape settings because it requires less maintenance and is less vulnerable to traffic. Performance of landscape plants is judged by their physical appearance, therefore, tolerance of leaves to salt-laden water on their surfaces is a critical trait for selecting landscape plants for recycled water irrigation.

The table of species screened for salt tolerance can be found on page 7. GP

New Free Publications on the Web for Home Gardeners

Communications Services, a branch of the Division of Agriculture and Natural Resources, produces a variety of practical, research-based educational materials to assist Cooperative Extension personnel in their outreach efforts. The “8000 Series” is a collection of web-based publications available free for downloading that delivers up-to-date information on many topics including those relevant to home horticulture. Several new publications have recently been developed, partially funded by the Elvenia J. Slosson Endowment. They include *Navel Orange Split* (8038), *Compost in a Hurry* (8037), *Sago Palms in the Landscape* (8039), *Water Conservation Tips for Home Gardeners* (8036) and *Turf Selection for the Home Landscape* (8035). Other 8000 series publications for home gardeners are being developed, including four on fruit tree care and a calendar of operations for various fruit tree species. These materials can be viewed and downloaded at the Communications Services web site: **anrcatalog.ucdavis.edu** GP

Notes From the Chair... by Heiner Lieth

As we go into the winter, we find ourselves planning for growth in the department, although we are temporarily constrained be shrinking finances from the state. While this can be very difficult, we are seizing the opportunities that present themselves and are working actively to create opportunities. I am currently developing three separate endowments in support of (1) floriculture, (2) nursery and (3) arboriculture. We also have opportunities here on campus.

New Office and Laboratory Space

The new **Plant and Environmental Sciences (PES) Building** is nearing completion in the central campus area north of Hunt Hall. Faculty from the **Department of Agronomy and Range Science** and the **Land, Air and Water Resources Department** will be relocating to this facility in early 2002. The EH Department has also acquired space in this new building and three of our faculty members (Michael Barbour, Alison Berry and Truman Young) will be moving their research programs to new offices and laboratories. This will no doubt facilitate many opportunities for collaborative research among colleagues from all three departments. In future, we may be referring to the space in the PES Building as EH's "North Campus Facility" and our original department complex will be renamed EH's "South Campus Facility".

Student Activities

The now-annual Fall Student Orientation and Spudfest served to introduce new EH undergrads and graduate students to the people and workings of the department as well as feed them enough baked potatoes to keep them carbo-loaded for weeks. Faculty members outlined their research programs and acknowledged the students working in their labs. Staff members described the services they provide and identified who could make sense of the many vagaries of college life. Then it was time to eat and department members went overboard to provide a banquet of potatoes and toppings, salads and desserts in an "all-you-can-eat" atmosphere. A good time was had by all, although one hungry graduate student remarked, "Spuds are great but why couldn't it be a Steakfest?"

Congratulations are in order for Soo-Hyung Kim who finished his Ph.D dissertation on *Photosynthesis Models and Canopy Management Optimization in Cut-Flower Roses* and has taken a postdoctoral position at the USDA research facility in Beltsville, Maryland. Rik Smith, a Ph.D. candidate working with Alison Berry, is team teaching ENH 144, Trees and Forests, with Michael Barbour and Carolyn Bledsoe of the Land, Air and Water Resources Department with a class enrollment of 102 students.

Faculty Pursuits

Michael Barbour, Truman Young and Richard Evans spent time in Barcelona, Spain developing a collaborative research project with colleagues at **IRTA (Institut de Recerca I Tecnologia Agroalimentaries)** involving water use of landscape plants. Alison Berry is on sabbatical leave at the **Harvard Forest** in Cambridge, Massachusetts, studying the impacts of urbanization on landscapes. Dave Burger is spending his sabbatical at **UC Riverside** and probably as many Southern California golf courses as he can find. In his absence, I am teaching ENH 1 Introduction to Environmental Horticulture and Urban Forestry with 48 students. Don Durzan is working with nuclear scientists in Ukraine to re-employ their expertise in the development of environmental sensing equipment. Truman Young is teaching the ever-popular ENH 6, Introduction to Environmental Plants, and has 56 students swarming over the campus to learn plant identification.

Michael Reid has been doing his usual globe trotting, spending time in Pisa, Italy to attend Ph.D. student, Antonio Ferrante's, successful dissertation defense. Antonio plans to return to EH in December for several weeks. Michael then traveled to Mexico for a presentation to the **Mexican Flower Council**. He also gave the keynote address to a meeting of the **International Floral Distributors** in New York City in October.

I have also done some globe trotting myself, traveling to Germany to collaborate with colleagues on research and to visit the NTV (Greenhouse Technology Exhibition) in Amsterdam.

Tom Ledig of the **Institute for Forest Genetics** was recently elected a Fellow of the **American Association for the Advancement of Science** for "distinguished contributions to the conservation of genetic resources in forest trees and to knowledge of the genetic bases of rarity". Congratulations, Tom!

New Visiting Scholars

Dr. Pushpendra Chauhan has arrived to work in my lab for a year. Dr. Chauhan is an associate professor at the College of Agricultural Engineering and Technology in Junagadh, India. His area of interest is greenhouse and nursery energy management.

Staff Happenings

Ron Lane has been working tirelessly with campus planners to secure acreage for the department's future field research site. We will be losing our current field plots to construction of a campus conference center and hotel. Greenhouse staff member Ahmet Gulcu and his wife, Maria, welcomed their son, Adam Muhammad Hickmet Gulcu, born on Jumma, the 16th of Shaban, 1422 (that's Turkish for November 2, 2001). Congratulations, Ahmet and Maria! GP

Salt tolerance of landscape plants and California native grasses grown under sprinkler irrigation with two salt (NaCl) concentrations. LOW = >50% growth reduction, MODERATE = 10-50% reduction, HIGH = <10% reduction.

Plant species	Sprinkler irrigation with 1500 mg·L^{-1} salt	Sprinkler irrigation with 500 mg·L^{-1} salt
Woody landscape plants		
Abelia grandiflora 'Edward Goucher' (Abelia)	LOW	LOW
Acacia redolens (Redolen Acacia)	HIGH	HIGH
Albizia julibrissin (Silk Tree)	LOW	MODERATE
Arbutus unedo (Strawberry Tree)	MODERATE	HIGH
Buddleja davidii (Butterfly Bush)	LOW	LOW
Buxus japonica (Janpanese Boxwood)	HIGH	HIGH
Ceanothus thrysiflorus (Ceanothus)	MODERATE	HIGH
Cedrus deodara (Deodar Cedar)	HIGH	HIGH
Celtis sinensis (Chinese Hackberry)	LOW	LOW
Clytostoma callistegioides (Trumpet Vine)	LOW	LOW
Cornus mas (Cornelian Cherry)	LOW	LOW
Cotoneaster microphyllus 'Rockspray'	LOW	MODERATE
Escallonia rubra (Escallonia)	MODERATE	HIGH
Euryops pectinatus (Golden Marguerite)	LOW	LOW
Forsythia intermedia (Forsythia)	MODERATE	HIGH
Fraxinus angustifolia (Raywood Ash)	LOW	MODERATE
Ginkgo biloba (Ginkgo)	LOW	LOW
Jasminum polyanthum (Jasmine)	MODERATE	HIGH
Juniperus virginiana 'Skyrocket' (Juniper)	HIGH	HIGH
Koelreuteria paniculata (Goldenrain Tree)	LOW	MODERATE
Lantana camara (Lantana)	MODERATE	HIGH
Liquidambar styraciflua (Liquidambar)	LOW	LOW
Mahonia pinnata (California Holly Grape)	LOW	MODERATE
Myrtus communis (True Myrtle)	MODERATE	HIGH
Nandina domestica (Heavenly Bamboo)	LOW	MODERATE
Nerium oleander (Oleander)	HIGH	HIGH
Olea europea 'Montra' (Dwarf Olive)	HIGH	HIGH
Pinus cembroides (Mexican Pinon Pine)	HIGH	HIGH
Pistacia chinensis (Chinese Pistache)	LOW	LOW
Pittosporum tobira (Tobira Pittosporum)	HIGH	HIGH
Plumbago auriculata (Cape Plumbago)	HIGH	HIGH
Prunus caroliniana (Carolina Laurel Cherry)	LOW	HIGH
Quercus agrifolia (Coast Live Oak)	MODERATE	HIGH
Rhaphiolepis indica (Indian Hawthorn)	HIGH	HIGH
Rosa sp. (Rose)	LOW	LOW
Sambucus nigra (Elderberry)	LOW	MODERATE
Sapium sebiferum (Chinese Tallow Tree)	HIGH	HIGH
Washingtonia filifera (California Fan Palm)	HIGH	HIGH
California native grasses		
Bomus carinatus (California Brome)	MODERATE	HIGH
Deschampsia caespitosa (California Hairgrass)	LOW	MODERATE
Deschampsia elongata (Slender Hairgrass)	MODERATE	HIGH
Elymus glaucus (Blue Wildrye)	HIGH	HIGH
Festuca californica (California fescue)	HIGH	HIGH
Melica californica (California Melic)	LOW	LOW
Muhlenbergia rigens (Deergrass)	HIGH	HIGH
Poa scabrella (Pine Bluegrass)	LOW	MODERATE
Sporobolus airoides (Alkali Sacaton)	HIGH	HIGH
Stipa pulchra (Purple Needlegrass)	HIGH	HIGH

Dawn Redwood Cont'd from page 2

40 miles south of Modaoqi, near the even smaller village of Shuishaba ("the place of the water pine"). Chaney wanted to walk on to Shuishaba, but Silverman tried to talk him out of it. Chaney was 58 and suffering from asthma. He was without medication and the route would take them over a dangerous, 6000-foot-high mountain pass during winter storm conditions. The trip would require two days of strenuous hiking and there was only one village along the way to provide overnight shelter. Despite the potential threat to his health Chaney was determined to see more than "three lousy trees".

The group's efforts were rewarded when they reached the Shui-hsu Valley where 100 residents lived in the village of Shuishaba. Thousands of dawn redwoods grew in narrow canyons which opened into the valley. Most were 50 to 60 feet tall and grew scattered among the rich diversity of hardwoods which filled the canyon bottoms. Rice and other crops were cultivated in the valley and Chaney guessed that it had once been covered with a dawn redwood forest that had been cut down for timber and to prepare the area for agriculture. Indeed, he interviewed several villagers who regularly harvested dawn redwood for making house timbers, furniture, and coffins. At the same time, most of the local people thought of dawn redwood trees as sacred and bringing good luck.

Chaney found dawn redwood trees to be part of a rich, riparian, bottomland forest. Its most common associates are like those recorded from the great northern hemisphere Paleogene forest of 65 to 24 million years ago: beech, birch, cherry, chestnut, Chinese fir, dogwood, elm, fig, hornbeam, maple, mulberry, oak, poplar, sassafras, storax, sumac, sweet gum, tupelo, willow, and yew. The modern local climate is also similar to that ancient regional climate. Winters are mild (freezing temperatures and snow are rare) and somewhat dry, summers are warm and wet; annual rainfall averages 53 inches.

Chaney, Merrill and others sent out thousands of seeds of dawn redwood for planting in Asia, Europe, and North America. Today the tree grows in public and private gardens and is found in places as cold as southeastern Alaska, British Columbia, and Massachusetts. "Cleary," wrote Chaney later in his life, "*Metasequoia* is a tree suited to live in regions much colder than its present home in China." Chaney believed that the dawn redwood survived in central China only because human settlement of the area was relatively recent. The village of Shuishaba has a history extending back only 200 years, and the oldest homes are built of dawn redwood timbers. "This inaccessible area is one of the few regions in China which has not been cleared of its forests by Chinese farmers," said Chaney. "Were it not for its remoteness, all of the *Metasequoias* might have been cut down centuries ago, and our knowledge of this tree would be confined to what we can learn from its fossil remains."

Thirty-two years after Chaney's visit, in October of 1980, researchers from the **California Academy of Sciences** revisited Modaoqi and the Shui-hsu Valley. The village of Shuishaba had become the commune of **Xiaoke**; today 11,000 commune members live in the valley. Paired photographs taken in 1948 and 1980 show that rice terraces have extended upslope, taking the place of previous forests. While Chaney was able to collect many dawn redwood seedlings and saplings from the forest floor on his trip, the Cal Academy group visiting in 1980 noted that they were completely absent. The Chinese government's Forest Bureau protects and keeps records on all dawn redwood trees, but they do not extend this protection to the dawn redwood's habitat. The Cal Academy group hypothesized that increased human population in the Shui-hsu Valley has added too much disturbance to the forest floor to permit seedling establishment. They expressed concern that this lack of protection could make dawn redwood go extinct in its last natural habitat.

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