GROWING Points

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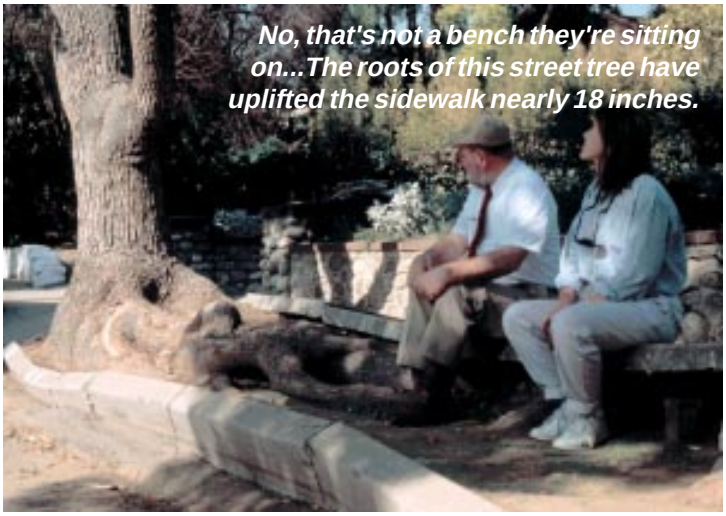
Tree Root and Urban Infrastructure Conflicts: Symposium Sets Research and Education Goals

by Linda Dodge

An estimated six million trees line the streets of California cities, providing environmental, aesthetic, social and economic benefits to communities. When conflicts arise between tree growth, especially tree root growth, and the urban hardscape, however, trees can be viewed more as liabilities by city management agencies. Approximately $70 million is spent annually statewide due to conflicts between street tree root growth and sidewalks, curbs, gutters, and street pavement. Although most of these costs are currently covered by municipalities, a trend is developing that will require property owners to shoulder more of the burden.

A symposium was held in late March at UC Davis to address this issue with the intent of developing strategies to reduce urban hardscape damage attributed to tree roots. Sponsored by the University of California, UC Cooperative Extension, the USDA Forest Service, the Elvenia J. Slosson Endowment Fund, and the Western Chapter of the International Society of Arboriculture, the two-day symposium brought together nationally and internationally renowned researchers, educators, tree managers, landscape architects, infrastructure engineers and urban planners. Their objectives were to determine the current state of knowledge concerning root-hardscape conflicts, identify and prioritize research needs, and develop a multi-disciplinary research and education plan for reducing infrastructure damage. During the initial sessions, researchers and practitioners shared their latest findings and experiences concerning urban trees and hardscape. The second day of the symposium was devoted to developing priorities for research and viewing demonstration projects in the field.



No, that's not a bench they're sitting on...The roots of this street tree have uplifted the sidewalk nearly 18 inches.

Research Perspective

Dr. Greg McPherson of the Western Center for Urban Forest Research and Education (a unit of the USDA Forest Service housed at UC Davis) related some surprising survey statistics on costs due to tree root-infrastructure conflicts. Of the $70 million spent annually in California, 61% goes for hardscape repair, 13% for liability and legal fees, 10% for tree removal and replacement, 8% for prevention and mitigation efforts, and 8% for administration and inspection. Sidewalk repair alone costs $23 million each year and in some cities, such as Los Angeles, property owners are required to pay the bill. Annual legal costs due to trip and fall claims are $9 million statewide, with the average payment being $6,245. Californians are paying twice as much for injury claims as they are for efforts to prevent or mitigate the problem. Tree removal and replacement with smaller-statured species is leading to a "down-sizing" of the urban forest and a loss of the benefits that large-canopied trees can offer. Finally, survey results revealed the most important factors associated with urban hardscape damage attributed to trees are restricted planting space, incorrect species selection, shallow soil due to a hardpan or other root-limiting zone, tree size regardless of species, fine-

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textured or compacted soils, and inadequate site design or engineering.

Dr. Larry Costello of UC Cooperative Extension in San Mateo and San Francisco Counties shared the results of a study conducted in Modesto with the cooperation of Ed Perry, UCCE farm advisor in San Joaquin County. They looked at characteristics of soils at tree sites with and without sidewalk damage to see if factors such as fine texture, poor structure, shallow hardpan or high water table contributed to tree root-hardscape conflicts. They found no association of soil conditions with the potential of Modesto Ash for causing sidewalk damage and suggested that other factors, such as rootstock variation, may have some influence on this species' damage potential.

Cultivar selection based on root architecture is the subject of Dr. Dave Burger's research at the Environmental Horticulture Department at UC Davis. He evaluated seedlings of evergreen or Shamel ash (*Fraxinus uhdei*) and Chinese pistache (*Pistacia chinensis*) in lab and field experiments for their ability to produce downward growing roots as opposed to those growing more horizontally. These selections are currently being tested to see if the deep-rooting characteristic persists under conditions of vegetative propagation. If successful, these cultivars may provide alternatives or better rootstocks for plantings near sidewalks or curbs.

Dr. Gary Watson of Illinois' Morton Arboretum, the current president of the International Society of Arboriculture, put the topic of tree root and infrastructure conflict into an historical perspective. In the past twenty-five years, about 3% of the articles published in the ISA's *Journal of Arboriculture* have related findings in this area and 2% of the grants funded by the ISA Research Trust have addressed this issue. These numbers do not seem to adequately represent the current level of interest in this area of research. Over the next two years, The ISA Research Trust will be leading the National Urban and Community Forestry Research and Technology Transfer Assessment. This effort will establish new priorities and funding recommendations for the next decade and Dr. Watson feels the issue of tree root and infrastructure conflicts will figure prominently in this process.

Dr. Edward Gilman of the University of Florida presented his research on the use of root barriers, a mitigation technique often used to deflect root growth away from hardscape elements. His field experiments with American sycamore (*Platanus occidentalis*) and Southern live oak (*Quercus virginiana*) showed that roots were directed downward by the barriers but tended to grow under them. Once beyond the barriers, roots grew upward into the shallow soil levels with a substantial number doing so immediately beyond the barriers, forming so-called "J roots" which may potentially compromise tree stability.

Dr. Lew Feldman of UC Berkeley has studied the physiological responses of roots to impedance. He found when roots encounter a barrier to elongation or primary growth, they adapt by converting to secondary growth or thickening. When induced to thicken by impedance, roots as far down as two feet below ground can cause displacement at the soil surface. This response seems to be connected with levels of the plant hormone ethylene in root tissue. Selection for tree cultivars with roots less sensitive to ethylene may be one way to reduce urban hardscape damage.

Dr. Nina Bassuk of the Urban Horticulture Institute at Cornell University shared her latest findings concerning the use of "structural soils" for trees in urban plantings. Over the past several years, she has developed and refined a soil mix providing increased underground space for tree roots without compromising the load-bearing needs of streets and sidewalks. Combining angular crushed stone and clay loam soil with hydrogel as a binding agent or tackifier, this structural soil mix forms a matrix strong enough to support the weight of concrete and vehicles while allowing roots to grow through the large pores containing optimum levels of oxygen and moisture. Many field trials are ongoing worldwide using the "Cornell" or "CU Soil" in new urban tree installations. Dr. Bassuk hopes to form an Internet-based forum for evaluating the success of these trials. The advent of supersonic air excavation techniques that do not damage root systems may make possible the retrofitting of established sites with the

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News from the Western Center for Urban Forest Research and Education *By Dr. Greg McPherson (http://wcufre.ucdavis.edu)*

A new technology transfer specialist in urban and community forestry will be serving the West beginning August 7. Jim Geiger brings over 20 years of experience working with individuals and community organizations to this new position with the USDA Forest Service. From 1978-1993 he served as the Urban Forestry Program Manager with the California Department of Forestry and Fire Protection and prior to this he worked as a City Forester in Chicago. Mr. Geiger will be located with scientists at the Western Center for Urban Forest Research and Education on the UC Davis campus. There he will assist with the development of cutting-edge technologies and training programs from science-based information, as well as extend the Center's research expertise to solve local problems and build community capacity.

The Western Center for Urban Forest Research and Education is partnering with UC Davis's Land, Air, and Water Resources Department to develop a computerized decision support tool for urban watershed management in Los Angeles. The 3-year project received $517,000 from the California Department of Forestry to develop and test a computer-based tool that watershed managers can use in the field to evaluate the cost-effectiveness of environmentally friendly landscape practices. Such a tool is needed to implement best management practices (BMPs) aimed at reducing stormwater runoff and landscape irrigation water use, conserving energy, and recycling green waste. Drs. Susan Ustin and Qingfu Xiao (LAWR) will monitor the effectiveness of BMPs already installed at a South Central LA residence, and develop the model's hydrologic component. Drs. Jim Simpson and Greg McPherson (Forest Service's Western Center) are working with graduate student Virak Dee to model impacts of tree shade on building energy use. Jeff Wallace of EarthView Environmental Computing will program the user-interface. Andy Lipkis, President of the non-profit TreePeople, will direct application of the tool by trained watershed managers in a San Fernando Valley demonstration project. The urban watershed auditing tool will reside on the world wide web and be transferable to other regions.

California Indians used horticultural techniques such as burning and coppicing to manage stands of redbud (left) and deergrass (below) for the production of basketry materials.

California Indian Horticulture

by Dr. Kat Anderson, National Plant Data Center, Natural Resources Conservation Service, Env. Hort. Dept., UC Davis

Editor's note: Following are excerpts from an article written by Dr. Anderson for the California Native Plant Society's journal, Fremontia (Volume 18, No. 2, April 1990).

For millennia native people have used the vast diversity of California's flora as a source of food, medicine, basketry, weapons, tools, games, shelters, and ceremonial items. Plants were integral to every facet of Indian culture, accompanying people in major rituals and life events such as childbirth, puberty rites, burial practices and religious festivals. Plants were talked to, prayed for, and thanked with offerings. Deference to the living spirit of plants, as well as continual use of plant parts, was believed to be essential to ensure a sustained yield and diversity of plants to meet Indians' cultural needs.

This ancient relationship that Indians maintained with plants included the protecting and "tending" of favored plant species using an array of horticultural techniques. Through coppicing, pruning, sowing, weeding, burning, digging, and selective harvesting, California Indians encouraged desired characteristics of individual plants such as larger leaf size, branch elongation, bark color, flowering stalk strength and number, and straighter rhizomes. On a larger scale, Indians managed plant mosaics, to attract wild game, eliminate brush for increased visibility and ease of movement, and encourage a diversity of food crops.

Today California Indians often refer to this horticulture as "caring about" the plant. It involves activities such as pruning diseased parts of favored plants, weeding around plants to decrease competition and aerate the soil, replanting the smaller bulblets of harvested plants, and scattering seed.

Modern Indian people of tribes such as the Yurok, the Southern Sierra Miwok, the Hupa, the Pomo, the Chuckchansi Yokuts, and others still continue a tradition of indigenous horticulture.

Although missionaries, anthropologists and settlers provide us with the earliest written records of California Indian cultures, their perception is that thousands of years of Indian plant harvesting had little influence on the shaping of California plant communities. The degree of influence has recently gained increasing attention among anthropologists, ecologists and resource managers and it is changing the image of the California Indian from one of a hunter-gatherer to that of horticulturist.

Recent evidence suggests that, for the California Indian, the harvesting of plant materials required rigorous, patient work, long before the weaving of an Indian basket, the making of a weapon, or the eating of a meal could begin. Indians chose their harvesting sites carefully with respect to environmental factors such as soil type, light, and moisture in order to provide the best conditions for growth of preferred plants. Initial management of the selected sites was often necessary before a sufficient quantity of any of these plant materials could be harvested.

California Indians practiced a variety of vegetation management methods the most prevalent of which were coppicing, soil and weed management, tillage, and burning. These horticultural techniques were applied to plant communities for the purposes of improving wildlife habitat, facilitating seed gathering and increasing forest visibility. Techniques were also applied to individual plants to assure the availability of some useful plant part, either edible or utilitarian, and/or to change the plant's morphological characteristics, usually for utilitarian purposes.

Coppicing

Many cultural products made by California Indian tribes for domestic use required special types of branches such as looped stirring sticks, rods for baskets, and arrows. The best plant materials were long, straight, slender switches with inconspicuous leaf scars, and no lateral branching.

Called "withes" or "sprouts" in the literature, these types of branches seldom occurred naturally on mature plants, and therefore, to obtain a sufficient supply, shrubs were coppiced (cut to almost ground level) at least one full growing season before harvest. A shrub that had never been harvested or coppiced before, in most cases, contained very few "usable" shoots (defined as twelve inches or longer with no lateral branching).

Interviews with North Fork Mono, Chukchansi Yokuts, and Central and Southern Miwok individuals reveal that the severe pruning (coppicing) of plants is still conducted today with pruning shears or a hand or power saw. The technique is mainly applied to shrubs for the collection of branches for basketry materials. Some of the species still coppiced include redbud (*Cercis occidentalis*), deerbrush (*Ceanothus integerrimus*), buckbrush (*Ceanothus cuneatus*), sourberry (*Rhus trilobata*), red

willow (*Salix melanopsis*) and sandbar willow (*Salix hindsiana*).

Each of these plant species responds to pruning by vigorously sprouting new shoots from dormant or adventitious buds. The result is increased numbers of long, straight, slender switches with inconspicuous leaf scars, and no lateral branching. These are the characteristics most valued by basketmakers. This contrasts with a wild shrub which has a mottled, cracked bark and twisted branches that are forked and often brittle. Where the twig or branch joins a larger branch or fork there is a notably more fragile area, making this section unsuitable for basketry. Consistent, frequent pruning produces a plant of smaller stature, with many small-diameter boles that are easy to reach and cut, saving the basketweaver harvesting effort and time.

Soil and Weed Management

The roots of species such as sawgrass (*Cladium mariscus* var. *californicum*) the rhizomes of sedge (*Carex barbarae*) and the rhizomes of bracken fern (*Pteridium aquilinum*) were harvested by California Indians to provide the structural and design elements in baskets.

Roots and rhizomes were generally dug in the fall or winter after sufficient rains and before the ground froze, although all times of the year have been documented, depending on the plant species. The preferred digging implement of most California Indian tribes was a sharpened digging stick made of mountain mahogany, buckbrush or some other hard wood, because it allowed economical harvesting without breaking the length of the plant part. Native Americans dug down till they hit the rhizome or root and then delicately followed along its length, moving back the dirt with their hands. The rhizome or root was then torn or cut from the parent plant. Roots of ponderosa pine (*Pinus ponderosa*) and gray pine (*Pinus sabiniana*) were harvested with a small obsidian axe or by slowly burning through the green root with a small fire.

Long straight roots or rhizomes, free of branching, with few or no kinks, unimpeded by rocky soils, or weed competition were preferred by basketweavers. Again, these types of underground plant parts seldom occurred naturally. Therefore, areas were carefully selected and managed to create suitable growing conditions to promote the desired characteristics.

Conifer roots, fern rhizomes, and sedge rhizomes are very much affected by the types and conditions of the soil in which they grow. When the growth of a root or rhizome is not restricted by soil compaction, or weed competition, its size and quality significantly increase. Therefore, when harvesting rhizomes and roots, Indian basketweavers selected sandy soil types that produced the best plant material. In these sites, the rhizomes grew easily in the loose soils and reached great lengths. Silt and clay beds usually were not suitable areas for harvesting, since the soils were not

Harvesting of straight redbud shoots from shrubs pruned the previous year. The shoots will be used in the making of a cradleboard.

easily penetrated, reducing the rhizome length and straightness.

The cultivation of the proper kind of sedge or bracken rhizomes (long, straight, few bends or kinks) involved the cutting of rhizomes from the parent plant, and weeding around the plant. This caused rapid elongation of new, long and straight rhizomes to grow out of the "spur" of the parent plant with lengths of up to six feet recorded in the literature. In the case of conifer roots, sometimes sandy soil was hauled in and placed around the roots of certain trees to provide a soil medium that produced straighter and longer roots. The Indian harvesting of conifer roots of lengths up to four feet have been recorded. Conifer roots with gnarls and knots make splitting the roots difficult.

Sedge rhizomes, bracken fern rhizomes, gray pine roots and ponderosa pine roots are still highly valued by gatherers from various tribes (Miwok, Pomo, and Maidu) for basketry starts, sewing strands and foundations of coiled baskets. Tools used today include a digging stick, metal fork or trowel.

Little is known about the impacts of Indian soil and weed management or the pruning of roots and rhizomes on selected plant species. Indians today often assert that Indian tending of areas stimulates increased vegetative production, actually increasing the size of a managed tract.

Tillage and Burning

The major underground plant parts harvested by California Indians for foods were bulbs, tubers, and corms. Major genera commonly harvested included *Brodiaea, Calochortus, Allium, Perideridia,* and *Camassia*. California Indians generally dug bulbs and corms with a sharpened digging stick in the spring or summer after the plants had leafed out, flowered or gone to seed.

Underground storage organs are an important means of propagation among perennial plants. Many of the California native bulbs and corms important to Indians can reproduce by offsets, which occur in the sheath of the stem or around the base of the bulb.

Tillage is defined as the loosening of the soil to harvest underground perennial plant parts such as roots, corms, bulbs, and tubers. It also may involve replanting or subsequent dividing of underground parts and leaving of individual fragments or smaller clumps in the soil.

Digging with a digging stick has generally not been considered a management technique by resource managers or scientists. It is possible, however, that the digging of certain bulbs, corms and tubers actually was a form of "tilling" and "thinning" which resulted in enhancement of certain plants, both in quality and numbers.

Propagation of tuberous plants by hunting and gathering groups has taken various forms. The Cahuilla Indians selectively harvested the larger corms for food, leaving or replanting the cormlets to ensure a crop the following year. Harvesting of corms, bulbs, and tubers by Pomoans in the California Coast Range, aerated the soil and resulted in the severing of bulblets from the parent bulbs, increasing the size of the plant bed. In California, Indian-potatoes (the corms of *Brodiaea* and *Calochortus* species) grew in "beds" and were easily harvested. The Karuk Indians claimed that by digging these corms more grew up each year. Wild onions also were reported to

EH Profiles Dr. Kat Anderson

Dr. M. Kat Anderson is an ethnoecologist for the USDA's National Plant Data Center and has been housed at UCD's Environmental Horticulture Department since 1998. The National Plant Data Center (NPDC) is part of the Natural Resources Conservation Service and seeks to provide comprehensive plant information to support conservation activities of various federal agencies. The PLANTS database (http://plants.usda.gov/) maintained by the NPDC provides a single source of standardized information on plants found in the United States and its territories. Dr. Anderson is coordinating a project which focuses on the collection of ethnobotanical data from indigenous peoples in the U.S. to learn more about ecosystem-based natural resource management. The information she collects, in cooperation with Native American communities, will be utilized to develop new techniques in ecosystem management.

In her research throughout California and in Central America, Dr. Anderson has studied the harvesting and horticultural practices of indigenous peoples and the potential effects of these practices on ecological systems. In addition to observing and interviewing contemporary individuals about past and present gathering and tending traditions, she also studies museum archives and artifacts to gain insight into the ways indigenous peoples related to the plant resources around them. Dr. Anderson also conducts field experiments to measure the ecological effects of simulated indigenous harvesting and management practices on plants at the individual and population levels.

One of the dominant themes coming out of Dr. Anderson's research emphasizes the role of indigenous people as horticultural ecologists who managed their wildland environment long before Europeans described the New World as an untouched wilderness. As efforts to restore disturbed ecosystems become more imperative, these native management practices could and should be adapted to current methods used by state and federal agencies responsible for the care of public lands.

Dr. Anderson received a Bachelor of Science Degree in Environmental Planning and Management from UC Davis, and both Master's and Ph.D. Degrees in Wildland Resource Science from UC Berkeley. After post-doctoral fellowships at the University of Kansas and UCLA, she joined the staff of the National Plant Data Center. She is currently affiliated with several academic departments and graduate groups at UC Davis and her expertise in the fields of ethnobotany and ethnoecology provides many possibilities for exciting research collaborations.

multiply in numbers when intensively harvested by indigenous groups. *Brodiaea* species grew in "plots" and were irrigated by the Owens Valley Paiute to increase the natural yield of the corms.

Some Indians today assert that the removal of bulbs and corms stimulates plants the following year. Several species of *Brodiaea*, *Allium* and *Sanicula* are still gathered by California Indian tribes. Digging implements include sticks, whittled broom handles, and crowbars.

Burning is defined as the deliberate setting and timing of fires in various plant communities. There are many historical accounts and several studies which describe the setting of fires by California Indians, suggesting that purposeful burning occurred in various plant communities. The reasons for burning were numerous. For example, Indians burned certain flat forest areas at intervals to destroy small trees and brush and leave open stands of the larger trees. This was to lessen the chance of surprise attacks by enemy tribes. Sometimes trees were felled with fire for different purposes such as providing a log as a bridge for crossing a stream.

Fires were set by the Indians for game management. Burns kept the underbrush down and facilitated the search for game. Many tribes also set fire to chaparral as a means of forcing out rabbits and other small animals in order to capture them for their flesh and pelts. Other rodents were smoked out and woodrat nests burned to capture them. Annual burning also ensured ample forage for deer, antelope, and tule elk. One of the ways in which grasshoppers and caterpillars were caught was to burn a field and then gather up the singed insects.

Another major purpose for the setting of fires was to modify the morphological growth of certain plant resources. Fires were set to increase berry production of certain plant species such as huckleberry (*Vaccinium* spp.). Fires were also set to manipulate the branch architecture and bark color of plants which could then be harvested the following year to make a particular cultural product. Many of the plants that provided basketry materials were repeatedly burned to provide straight shoots. Some Indian elders today recall that such species as maple, willows, redbud, sourberry and hazelnut were fired to stimulate the production of long withes. Certain bunchgrasses such as deergrass (*Muhlenbergia rigens*) were also burned to increase rhizome production thereby increasing the size of the colonies as well as encouraging the production of flowering stalks. Burning off the land increased the ease of harvest of certain plant parts. For example, fallen leaves and brush reduced the visibility of acorns and thus, increased the search time for these seeds. Therefore, burning under the oaks in certain areas enhanced the gathering of acorns.

Indians utilized fire in order to change plant species composition. Burning cleared brushlands and grasslands so that brodiaeas and other bulbous-rooted species useful for food would grow more abundantly. Areas in Southern California were burned to improve the production of seed-bearing plants such as chia (*Salvia columbariae*).

Years after Indians were forced off their lands, they continued to collect wild foods on adjacent lands in selected areas burned by ranchers and farmers. Indian informants still recall that the abundance and quality of mushrooms, sanicles, brodiaeas, and other valued plants were enhanced after burning.

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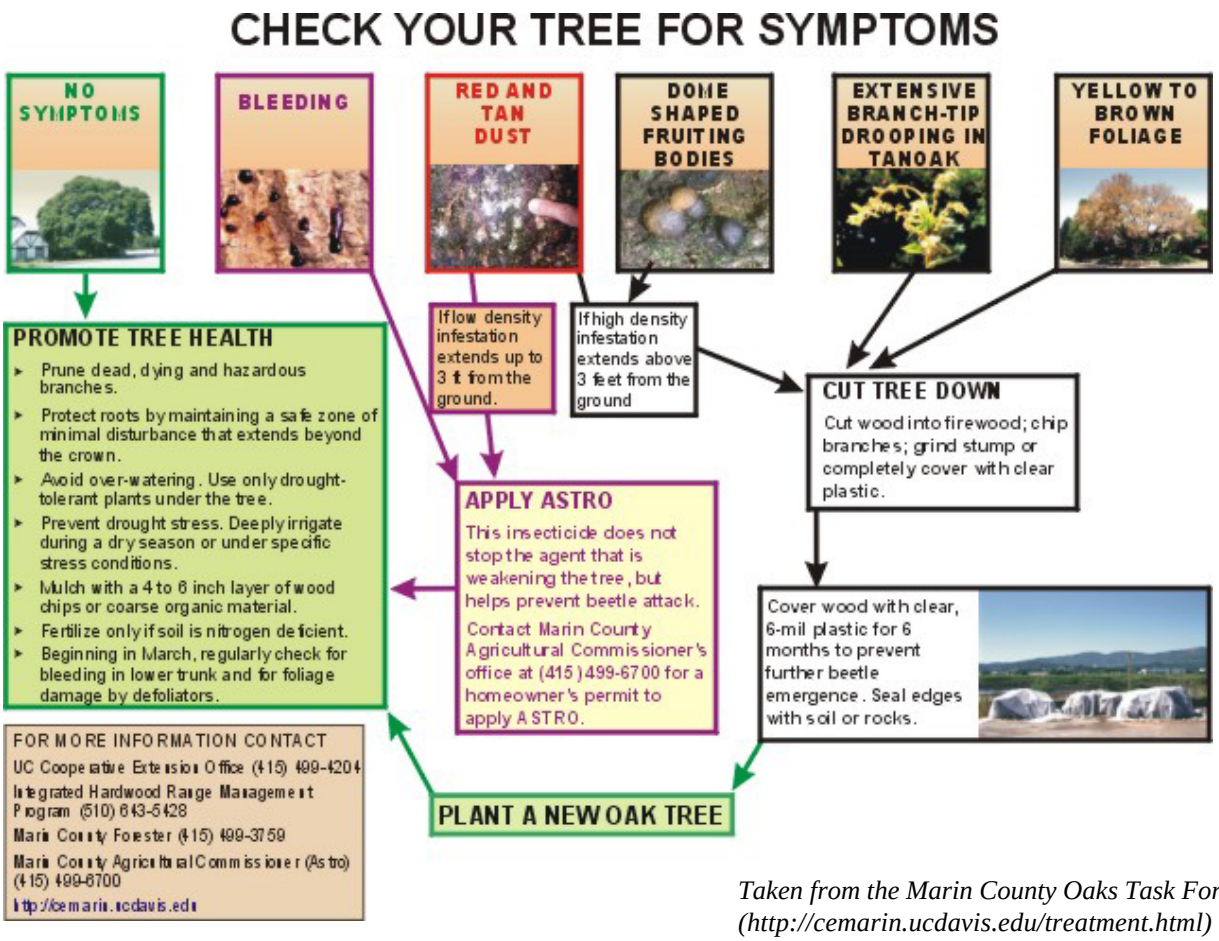


Taken from the Marin County Oaks Task Force Page: (http://cemarin.ucdavis.edu/treatment.html)

Update on "Sudden Oak Death": Phytophthora may be the cause

Since 1995, stands of coast live oak (*Quercus agrifolia*), black oak (*Quercus kelloggii*) and tanoak (*Lithocarpus densiflorus*) in California have succumbed in alarming numbers to an unknown malady identified only as "Sudden Oak Death". Outbreaks began in Marin County but soon coastal forests from Humboldt to Santa Barbara counties were affected. Symptoms included dark sap oozing from trunks, attack by bark beetles, drooping and browning foliage, attack by a variety of fungi and subsequent death of entire trees.

UC scientists and Cooperative Extension personnel from Berkeley, Davis and the affected counties formed the UC Oak Research Team to monitor the outbreak's progression, pinpoint the problem's cause and develop treatment solutions. Researchers in the fields of plant pathology, entomology, field ecology, urban forestry and remote sensing have pooled their energies to address this complex and urgent situation.

At the end of July, 2000, the research team announced the identification of a possible causal agent for "Sudden Oak Death". Dr. David Rizzo, a UC Davis plant pathologist, identified the culprit as a previously-unknown fungus species in the genus *Phytophthora*, a group of organisms well-known for pathogenic behavior. Related species caused the Irish Potato Famine of the 1840's, dieback of Port Orford cedars on the West Coast and decline of eucalyptus forests in Australia.

Commonly known as "water molds", *Phytophthora* fungi are found in soil, spread by swimming spores and thrive in cool, moist conditions. The species associated with "Sudden Oak Death" does not match any of the 60 known species in the genus and it is not known if it is native to California. The speed at which this pathogen has spread through the coastal forests suggests, however, that it may be an exotic invader to which the trees have no natural immunity.

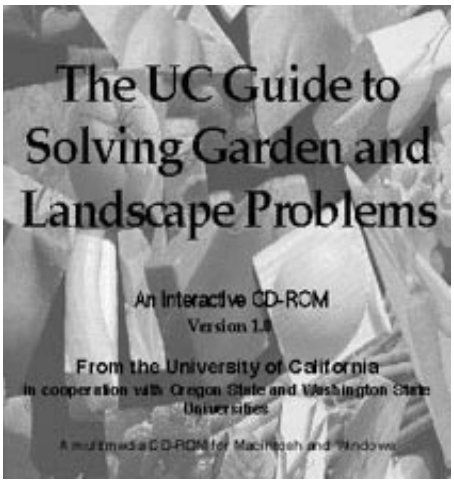
Despite the preliminary nature of their findings, the UC Oak Research Team felt heightened public awareness of the probable cause of "Sudden Oak Death" is imperative before the start of another rainy season. Because a soil-borne *Phytophthora* pathogen is involved, Rizzo and his colleagues are urging the public to avoid transport of soil from coastal areas to other forested parts of California. This includes washing down vehicle tires, pets and footwear before leaving affected counties. In addition, transport of wood from affected areas should be strictly avoided.

As the UC Oak Research Team continues its effort to bring "Sudden Oak Death" under control, property owners with specimen trees are encouraged to give them optimum care and monitor for any symptoms. The public can follow the progress of research on "Sudden Oak Death" by visiting several excellent World Wide Web sites, including the Marin County Oaks Task Force Page (http://cemarin.ucdavis.edu/index2.html) and the UC Oak Research Team site (http://himalaya.cnr.berkeley.edu/oaks/#research).

-Linda Dodge

University of California Releases CD to Help Gardeners Solve 600 Common Pest and Disease Problems

by Pam Geisel, UCCE, Fresno County



A new tool from the University of California will help landscape professionals, Master Gardeners and backyard gardeners be better stewards of their own corner of the earth – their vegetable gardens and landscapes.

The UC Statewide Integrated Pest Management Project this spring released its new interactive garden problem solver on compact disc, *The UC Guide to Solving Garden and Landscape Problems*. The authors of this are Mary Louise Flint, Pam Geisel, Joyce Strand, and Cheryl Reynolds.

Designed for both Macintosh and PC computers, the CD helps gardeners solve more than 600 common pest and disease problems of fruits, vegetables, and woody ornamental plants. The CD contains more than 4,800 of IPM's renowned photographs to help identify pests and disorders of more than 40 different fruits and vegetables and more than 80 ornamental trees.

It offers suggestions for non-chemical pest control and tips to promote good plant health. It also shows the user how to eliminate unnecessary pesticide use and, if necessary, select pesticides that pose minimal risks to human health and the environment.

The new CD is available from local offices of UC Cooperative Extension or UC ANR Communication Services (phone 800-994-8849, fax 510-643-5470), or order online at

http://anrcatalog.ucdavis.edu.

Postharvest Update: New tool for keeping leaves green

By Dr. Michael S. Reid

Researchers in Michael Reid's laboratory including graduate student Antonio Ferrante, Emeritus Professor Wes Hackett, and postdoctoral researcher Don Hunter have discovered a new tool for keeping leaves fresh and green on cut flowers and potted plants. No, it's not green paint! Ferrante, who is visiting for a year from the Postgraduate School of the University of Pisa has been examining the leaf yellowing that is a major problem in some varieties of Alstroemeria. It is known that cytokinins like kinetin can delay leaf yellowing in many plants. Thidiazuron (TDZ), a compound that is used as a defoliant in cotton, is active, at very low concentrations, as a cytokinin. Reid's group has been using TDZ as a component of sterile media on which they are trying to tissue culture rhododendrons, grevilleas, and four o'clocks. The group decided to test the effectiveness of TDZ in preventing leaf yellowing of Alstroemeria. They found a spectacular delay of leaf senescence, even in cut flowers held in the dark, and have since demonstrated similar effects in lilies. Dr. Ann King, horticulture advisor in San Mateo and San Francisco counties, who is spending a sabbatical year in the Environmental Horticulture Department at UCD, is now testing the effects of TDZ on potted flowering plants (where leaf yellowing is also a problem). Preliminary results suggest that the treatment may have even more spectacular effects with potted plants. These novel uses of TDZ are likely to have considerable commercial potential, and the group has applied for a patent to cover its application to ornamentals.

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Linking Wildland and Cultural Conservation

Many public lands managed for timber, livestock, recreation and other resource values contain plants still culturally important to Indian groups. Yet Native Americans often remark that these plant populations are sparse, discontinuous, and of an unsuitable quality for use in the manufacture of cultural items. The Indians say that plants such as deergrass (*Muhlenbergia rigens*) in the Sierra foothills, or sedge (*Carex barbarae*) along streams, or bear grass (*Xerophyllum tenax*) in the northern ponderosa pine forests are poor quality and need to be harvested, protected, and tended. Elders remember how much more abundant mariposa lilies (*Calochortus* spp.) and Indian potatoes used to be, covering whole hillsides and meadows. Gatherers also notice how sparse berry and seed crops such as manzanita berries and acorns are today compared to half a century ago.

In many public land agencies the old management goals of plant protection and preservation have been replaced with the philosophy of encouraging natural processes. For example, the National Park Service plans to restore each park as nearly as possible to a structure within which natural fires and other natural disturbances may be allowed to occur. To do this, resource managers will not only need to assess the role Indians played in the past management and maintenance of ecosystems where plant resources were gathered, but also they will need to study Indian horticultural techniques and their impacts on vegetation.

This new knowledge may offer biologists, ecologists and resource managers alternative, innovative ways of managing noncommercial plant species and plant communities in wildlands. Therefore, Indian techniques to manage the vegetation should be tested and, where appropriate, combined with modern management practices. Since this knowledge will benefit public land management, Indians should be compensated for the services provided by their cultural knowledge. Compensation could occur through such activities as: facilitating Indian plant gathering as a legitimate land use; applying indigenous horticultural techniques to enhance cultural resources; and involving Indians in the design of plant studies.

Notes From the Chair... By Dave Burger

EHUF and Grad Students

Good luck to those EHUF students who graduated during the Spring Quarter. They are **Jennifer Frasier Birge, Joshua Burnaford, Venetia Cotter** (highest honors)**, Doug Jones, Michael Jow, Brian Koehler, Josh Marone, Jennifer McGaffey, Patrick Paumier, Angela Pratt, Rosalie Cabral Venterea, Ryan Wallace and David Yee.** Departmental Citations for outstanding undergraduate accomplishment went to **Venetia Cotter, Kathleen Donley** (will be finishing this summer), **Bear McGuinness** (Winter 2000), **Angela Pratt, Alaine Sommargren** (Fall 1999) and **Ryan Wallace**. In addition, **Patrick Paumier** received a Certificate of Recognition from the Botanical Society of America from Dr. **Judy Jernstedt** of the Agronomy and Range Science Department. This Young Botanist Award is presented to a graduating senior with a strong academic record and an interest in the plant sciences, who has demonstrated leadership qualities.

Congratulations go to **Carmia Feldman**, one of Dr. **Michael Barbour's** graduate students, who received a Master's Degree in Ecology. The title of her thesis is "The Structure, Composition, and Sampling Characteristics of Old-Growth Mixed Conifer Forests of the Western Sierra Nevada." **Helena Graces** is a PhD student at the University of Lisbon who is sponsored by the Portuguese Government to complete her studies in Dr. **Don Durzan's** laboratory. Her research deals with the responses of *Kalanchoe* to hypergravity as a function of reproductive capacity and programmed cell death. This study is also under the direction of Professor **Cristina Ubach** at the University of Lisbon and who is a frequent visitor to Dr. Durzan's laboratory. Progress reports have appeared in the *Bulletin for the American Association for Gravitational and Space Biology*.

Visiting Scholars

Professor **Huaquiang Dong** is a visiting Professor from China who is continuing the research on anti-cancer drug production in cells and by methods protected as patents in Dr. **Don Durzan's** laboratory. He is exploring the relations among gravitational forces, drug overproduction, and programmed cell death using a model developed in Durzan's lab and published in *Botanica Acta* 109: 268-277 (1996).

Dr. **Ann King**, horticulture advisor with UC Cooperative Extension in San Mateo and San Francisco Counties is spending her sabbatical leave in Dr. **Michael Reid's** laboratory, doing postharvest research on cut flowers and potted plants with the occasional able assistance of her sons, **Owen and Emery**. Ann also contributed to the department by acting as instructor for the upper division class, Analysis of Horticultural Problems (ENH 241) during Spring Quarter.

Dr. Reid's lab group continues to swell in numbers and we may soon need another building to house them all. Dr. **Mohammed Eraki** is here from Egypt to study effects of the anti-ethylene coumpound, 1-MCP, on carnations and sweet peas. **Tristane McCallum**, a recent high school graduate and friend of the Reid family, visitied briefly from New Zealand to experience life in the postharvest lab. High school student Michael Teng, a participant in the UCD Young Scholars program, worked under the supervision of Dr. Don Hunter to study proteins responsible for loosening of cell walls during the senescence of four o'clock flowers. **Fabio Mencarelli** has recently arrived from the University of Tuscia, Viterbo, in Italy to study molecular techniques used in postharvest research.

Some visitors to EH have gone on to bigger and better things. Dr. **Svetlana Dobritsa**, who was working in Dr. **Alison Berry's** lab, is now working for a pharmaceutical company in the state of Washington. **Lin-Ying Li**, graduate student of Dr. **Heiner Lieth**, is working for a biotech company in Davis. Dr. **Xun Guo**, who worked with Dr. **Lin Wu**, has gone on to take a position at a high tech computer company.

Faculty Activities

Recently retired professor, **Seymour Gold**, donated his extensive collection of books and files on environmental planning and management to UCD's Shields Library. The documents and files will be catalogued and the books will be put in circulation and designated as the "Seymour Gold Collection". Sy's generous gift will benefit many future scholars.

EH Department greenhouse display for Picnic Day 2000

Staff News

Lori Stehouer has resigned her position as **Michael Reid's** administrative assistant to attend graduate school at Temple University in Philadelphia to study microbiology. We wish her success. **Kasey Donovan**, SRA from Animal Science, has taken over to assist Michael in his duties as Agricultural Productivity Program Leader. Kasey's energy and enthusiasm make her well qualified for the task. **Dorothy Ross** has also joined

the Reid workforce to assist Michael in his duties as editor of the journal, *Scientia Horticulturae*. She is another welcome addition to the EH family.

Glen Forister, SRA and computer guru, recently observed recognition for his 25th year of service to UCD. We thoroughly congratulate him on this major accomplishment.

Department Happenings

EH hosted the "Stategies to Reduce Infrastructure Damage by Tree Roots Symposium" in late March along with the **Western Center for Urban Forest Research and Education.** Many ideas for research and education on this important topic came out of the two-day meeting involving invited researchers, arborists, construction engineers and landscape designers from all over the US and Europe (see story on page 1 of this issue).

Picnic Day fell on April 15th this year and thousands neglected their tax returns to come out and enjoy the festivities with the theme "Mooving into the Future". EH volunteers set up our greenhouse display near the library. This year, we gave away blooming marigold plants grown by senior **David Yee** for the occasion. They were a big hit and drew throngs to our display. Signs pointed the way from there to the EH complex where several students gave tours of the greenhouses. Volunteers also fielded a barrage of questions from visitors about growing ornamental plants indoors and out, reinforcing the rank of gardening as America's No. 1 pastime.

In May, the **Ornamental Horticulture Research and Information Center** (OHRIC) and EH hosted the annual OHECC meeting (Ornamental Horticulture Extension Coordinating Conference). Cooperative Extension advisors and Specialists belonging to the **Floriculture/Nursery, Landscape, Turfgrass** and newly-organized **Urban Horticulture** workgroups met to exchange information about ongoing research and form collaborations for new research projects. Presentations on water quality issues (including TMDL mitigation for impaired water bodies), the pros and cons of genetically-modified organisms (GMOs) and setting workgroup priorities based on target issues identified by the Division of Agriculture and Natural Resources sought to prepare advisors and specialists to meet future clientele needs.

Slosson Endowment Funds Horticultural Research for 2000-2001

by Linda Dodge

Elvenia J. Slosson was an avid horticulturist and founded the California Garden Clubs, serving as the organization's first president. Throughout her life, Mrs. Slosson encouraged individuals and local groups to work for the enhancement of both public and private outdoor environments. When Mrs. Slosson died in 1958, she left a gift in trust to the University of California to be used "for the advancement and promotion of the science and practice of horticulture, particularly including ornamental horticulture."

In 1970, the Regents of the University of California established the Elvenia J. Slosson Endowment Fund for the support of research and Extension education in ornamental horticulture. Research and education proposals are solicited annually by UC personnel and selected through a competitive review process by an advisory committee consisting of representatives from University of California campuses, Cooperative Extension and the California Garden Clubs.

The projects funded for the current year (2000-2001) represent many innovative aspects of ornamental horticulture research and education. Dr. Dave Burger will be working for a third year on "Selection and propagation of deep-rooted ornamental trees for urban environments". Dr. Larry Costello used Slosson funds to put on "Strategies to reduce infrastructure damage by tree roots: A symposium for researchers and practitioners" reported on earlier in this issue.

Pam Geisel (Environmental Horticulture Advisor, UCCE Fresno County) and Dennis Pittenger (Area Environmental Horticulture Advisor, UC Riverside) will be creating "Horticulture Notes for home, landscape and garden", a series of Web publications on home horticulture.

Dr. Lynda Goff, professor of Biology and Dean for Undergraduate Education at UC Santa Cruz, and Bret Hall, Assistant Director of the UC Santa Cruz Arboretum, will be creating a native garden with "Selection and display of California flora for the home gardener and landscape designer in the Monterey Bay Region".

Nicholas Sakovich (Farm Advisor, UCCE Ventura County) and Rose Hayden-Smith (4-H Youth Development Advisor, UCCE Ventura County) will develop a "Junior Master Gardener Program" to be offered in Ventura County through schools and at a farm worker housing cooperative. Chuck Ingels (Farm Advisor, UCCE Sacramento County) and Judy McClure (Master Gardener Coordinator, UCCE Sacramento County) will be adding enhancements and programs to their "Fair Oaks Horticultural Center".

Dr. Harry Kaya of UCD's Nematology Department will continue his fascinating work on "Molluscicidal nematodes for biological control of pest slugs". Dr. Antoon Ploeg (Assistant Extension Nematologist, UC Riverside) and Steve Tjosvold (Farm Advisor for Ornamentals, UCCE Monterey County) will be collaborating on "Bio-fumigation/ solarization for the control of nematodes and weeds".

Dr. Michael Reid and Dr. Wes Hackett of EH at UCD and Ellen Zagory of the UCD Arboretum will continue developing "Grafting for production of environmentally tolerant rhododendrons, azaleas and grevilleas". Giles Waines, Director, and Stephen Morgan, Curator, of the Botanic Gardens at UC Riverside, will develop "Ornamental selections of South African origin with educational interpretive displays". Dr. Lin Wu will be conducting "Studies of recycled water irrigation and performance of landscape plants under urban landscape conditions".

Nearly $190,000 was awarded this year by the Slosson Endowment for horticultural research. The Research Advisory Committee is currently considering revisions of the call for proposals for the 2001-2002 funding cycle that will clarify endowment goals and perhaps increase the level of maximum funding awarded. Watch for changes and view past research reports on the Slosson Endowment Web site:

(http://slosson.ucdavis.edu).

Symposium: continued from page 2

structural soil mix.

The European perspective on tree root and infrastructure conflicts was represented by Dr. Thomas Randrup of the Danish Forest and Landscape Research Institute in Hoersholm, Denmark and the UK's Dr. Mark Smith of the Institute of Hydrology in Wallingford, Oxfordshire. Dr. Randrup's survey of Danish cities found root intrusion into aging sewer systems is not perceived as a major problem, although $8 million dollars are spent on sewer repair or replacement annually. Two prominent examples of conflict between tree roots and infrastructure in the UK, according to Dr. Smith, are trenching for utility installation and building subsidence on shrinkable clay soils. Dr. Smith and his colleagues at the Institute of Hydrology are charged with reviewing and developing research in this area and producing a handbook for use by urban landscape developers, arboricultural professionals, utility and construction companies, and structural engineers that will provide accessible and easily understood information for all those working with trees.

In several California cities, staff responsible for concrete maintenance and those involved in street tree care are working under common jurisdiction to maximize the effectiveness of both programs.

Practitioners' Perspective

Several urban foresters from cities throughout California shared their experiences and innovative ideas for mitigating conflicts between tree roots and urban hardscape. In Chuck Gilstrap's city, Modesto, sidewalk repair crews work within the Forestry Division to facilitate coordination of root pruning and installation of root barriers with sidewalk removal and replacement. In addition, the city loans out several water jet tools used to create deeper channels for tree root growth in an attempt to discourage surface rooting. In contrast, Leonard Dunn's city, Sunnyvale, has brought the street tree program into the Public Works Department to facilitate interaction between staff involved in right-of-way concrete maintenance and staff involved in tree planting and care. They use root barriers, root pruning techniques and are experimenting with interlocking sidewalk pavers in their efforts to retain as many mature street trees as possible.

Walter Warriner of Santa Monica has successfully educated other agencies within his municipal government about the importance of urban trees and has developed a Community Forest Management Plan. A city forester now reviews all new development plans and "tree protection zones " are included. Gordon Mann, of Redwood City's Public Works Services, works closely with the city council and the public to retain as many large street trees as possible by setting limits on removals within each block and using larger-scale species for new plantings. As a result, property owners are more willing to allow city staff to try new techniques and to defer to the Public Right-of-Way in the name tree preservation.

David Gamstetter of the Municipal Forestry Department in Cincinnati, Ohio related the findings of a study on sidewalk failure in that city which sought to identify causal factors based on an examination of sidewalk repair histories. Several soil complexes were identified that were prone to frost action and had extensive repair histories. Repairs occurred equally on sites with and without trees and tree-related repairs did not occur during the first 15-20 years of sidewalk service life. Sidewalks that failed within the first 20 years may have provided easier access to opportunistic tree roots. The conclusion of the study was that trees play only a minor role in sidewalk failures.

Design and Engineering Perspective

Landscape architects and materials engineers are developing innovative ways for addressing the issue of tree root conflicts with urban infrastructure. Jim Urban, a landscape architect in Annapolis, Maryland, approaches the problem from the aspects of conflict avoidance, root guidance or hardscape resistance to root expansion. Conflict avoidance can be easily designed into a new landscape by providing larger tree planting spaces, use of the monolithic street and sidewalk design that eliminates the parkway strip, or use of a meandering curvilinear sidewalk design that provides more room for tree planting. Root guidance can be achieved by including root barriers (steel, copper or fabric mesh, or herbicide-impregnated fabric), gravel layers to direct root growth or structural soil in the design specifications. Designing hardscape elements more resistant to root expansion could involve using heavier concrete, a compressible subgrade (rubber or Styrofoam) or pavement with score points and a steel backing that would flex and become ramped over time as tree roots expand.

Oakland landscape architect Gary Mason suggests designing appropriate habitats for urban trees. Instead of planting in straight, evenly spaced rows, trees could be grouped in groves or clusters along streets in urban wilderness areas. Alternative materials for walkways could be used and design criteria could be tailored to accommodate trees in their mature stage.

Concrete engineers, George Seegebrecht of Skokie, Illinois and Dave Holman of Danville, California, emphasized the importance of basic design criteria in the mixing and pouring of concrete. The ratio of water

to cement is critical and the amount of trapped air can affect freezing and thawing. Joints should be placed in concrete so panels are approximately square; if the length to width ratio exceeds 1.5 to 1 cracking may occur. The shrinking and expansion common to clay soils caused by moisture variation often results in cracking of concrete, lending support to the view of tree roots as opportunistic exploiters of the resulting space.

Strategies for Future Research and Education

The morning session of the symposium's second day was devoted to prioritizing strategies for reducing root-infrastructure conflicts. The participants separated into three groups to brainstorm and prioritize in the areas of Root and Soil Management Solutions, Design and Planning Solutions and Engineering Solutions (Construction and Materials). From these prioritized strategies, the symposium participants developed action plans for research and educational programs.

In the areas of root and soil management, the need for continued basic research on root biology and physiology in the urban setting was identified. Species selection and cultivar development of trees for root architecture more compatible with building materials was seen as important. More information is needed regarding the long-term effects of root guidance methods (barriers, trenching, chemical control) on overall tree health. Research and outreach regarding soil management techniques were viewed as critical. Better site assessment, awareness of soil structure and management of soil compaction, drainage and temperature were among the most important factors. This group also emphasized the need for official recognition of the urban forest in municipal policy and design through benefit/cost analyses and consumer education. Better coordination of city and county agencies responsible for urban trees and infrastructure could foster a new urban design paradigm beneficial to all sectors.

The group charged with prioritizing design and planning solutions for tree root-infrastructure conflicts emphasized alternative designs for traditional urban elements. Street designs could be reevaluated to include non-traditional tree planting locations (groves or clusters), larger easements or bigger planting holes. Sidewalks could be redesigned, relocated or even eliminated. Alternative walkway or base materials need to be developed including flexible pavement and the use of structural soils should be more widely adopted. More applied research needs to be done on root biology and how growth is affected by root control measures such as pruning, guidance and chemical control. New instrumentation for remote sensing of roots could prove useful. Of prime importance is the education of stakeholders and consumers about new design and planning options and how they will benefit the urban forest.

Engineering strategies for eliminating tree root-hardscape conflicts were broken down into ideas for materials, design, site preparation, directional root growth and planning. Research and field testing of alternative pavement materials was seen as important, including stronger or flexible (rubberized) concrete and asphalt, the addition of rebar or wire mesh and inclusion of allelopathic chemicals or root toxins. The development of a tree/site design matrix could facilitate matching the planting site with a compatible tree species. The use of structural soil mix or compressible base materials during site preparation needs refinement and further field tests. Research is needed to determine appropriate soil volumes needed for healthy tree root growth. Innovations for directing tree root growth included trenching and culverts, geotextile barriers, injection of gel materials into soil to reduce oxygen at the concrete/soil interface, modifying soil temperatures to deter roots and increasing light levels to force root growth downward. The long-term effects of temporary repair methods such as concrete jacking to level walkways and sidewalk grinding and ramping need to be fully determined. Planning agencies need to match the life expectancy of landscape and hardscape elements so as to get the maximum service life out of each. Management agencies need to combine tree and sidewalk installation and repair efforts to maximize their efficiency.

After the separate brainstorming sessions, the symposium participants met again as a whole to compare the results of their labors. A coordinating committee was named and plans for a web site were discussed to monitor progress of the action plans created. All groups emphasized the need for more information about tree root growth and behavior in the urban setting, the willingness to create and test alternative designs and materials for streets and sidewalks, and the necessity of coordinated effort among municipal and county agencies to recognize the importance and dynamic nature of the urban forest. As one of the symposium's organizers, Dr. Larry Costello, said: "We need to develop a tree-friendly infrastructure as well as infrastructure-friendly trees."

Grading and design modifications allow this mature valley oak to thrive in the middle of a four-lane boulevard (Elk Grove, Sacramento Co.)

From the "eXtension Files"

Recent questions submitted to the Environmental Horticulture Dept.

From R. D. via e-mail:

The City of Dixon Parks & Recreation Commission has an ongoing issue that we would like to resolve regarding the danger of oleander poisoning. The City of Dixon utilizes oleander bushes for a portion of our park landscaping. Oleanders, as you are aware, are a very commonly used plant. We are aware that direct ingestion of oleander branches or leaves can cause illness, or possibly even death. The current concern, however, is the potential danger from indirect exposure, i.e., oleander branches soaking in a swimming pool, or inhalation of oleander flower pollen or "dust". Do these indirect means of exposure pose any threat to the public?

The toxic properties of oleander (*Nerium oleander*) are well documented and are caused by substances which, when ingested, act as cardiac glycosides and increase the force and speed of contraction of heart muscle and can cause cardiac arrest. Other symptoms include vomiting, sweating, blurred vision and dizziness and, for an adult, can begin as soon as four hours after ingesting as few as five leaves. Researchers have found the highest concentrations of cardiac glycosides in the seeds, roots and leaves of oleander plants but all parts are said to contain these substances. Red and pink-flowering varieties seem to have higher levels than white-flowering cultivars and levels of toxins vary with the seasons, being the highest during flowering.

Oleander poisoning in humans occurs regularly, most often accidentaly in young childern but also as a result of suicide attempts by adults. These cases are most often the result of direct ingestion of plant parts (leaves or flowers) and are rarely fatal. The hypothetical situation of toxins leaching from branches soaking in a swimming pool would seem to pose little threat since concentrations would be vanishingly small. There are no reports on the dangers of oleander pollen and the normal means of pollen dispersal for this species is by insects and not by wind. It would seem likely, therefore, that pollen is not easily dislodged from the flower. There is a documented case of oleander toxicity from inhalation of smoke during the burning of prunings and this means of intoxication (through lung tissue) warrants further investigation. Precautions should be taken near fires involving oleander plants.

Because oleander toxicity is a regular occurrence, successful clinical treatments are well documented and fatalities are rare if treated promptly. The cardiac glycosides found in oleander are similar to digoxin, a drug commonly used in heart disease therapy. A new method of treatment for digoxin intoxication has been used successfully in cases of oleander poisoning. Fragments of antibodies specific for digoxin (produced in sheep) are injected into the bloodstream. These fragments bind to molecules of digoxin or the similar cardiac glycosides found in oleander and prevent them from acting on cells of heart muscle. The substances are then excreted through the kidneys and patients are seen to improve with an hour.

The utility of oleander as a landscape plant seems to outweigh the danger of accidental or intentional poisoning through ingestion of plant parts. Indirect exposure seems to pose little threat to the public and most plantings of this shrub in public places are done with discretion. Accidental fires involving oleander plants should be handled with the knowledge that smoke inhalation could result in symptoms of oleander toxicity. Prompt treatment of symptoms is essential, no matter what the cause of exposure, and successful clinical treatments exist to minimize the potential for fatality.

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