

divining rod

Nematode-killing fungus being studied at PGEL

To the uninitiated, fungus which produces traps like lariats to kill nematodes and tobacco plants transgenic with human collagenase may sound like science fiction, but it's the brave new world at the Plant Genetics Engineering Laboratory at New Mexico State University.

This brave new world includes a project by molecular-biologist Champa Sengupta-Gopalan, nematologist Stephen Thomas, and PGEL Director John Kemp to genetically

engineer nematode-resistant crops. Nematodes are microscopic ground worms, root parasites which interfere with a plant's ability to utilize and transport water efficiently. In New Mexico, rootknot nematodes cause significant problems in chile and cotton. The implications nationwide are even broader as nematodes are prevalent in soybeans. Agricultural producers must increase irrigation and nitrogen fertilizer applications to compensate for the

nematodes' invasion of plant tissue.

There is a fungus, however, which can obliterate nematodes. It produces "traps" for the nematodes which are structured like lariats. These traps constrict the nematodes and secrete collagenase which helps the fungus digest the collagen of the nematode's skin. The PGEL scientists hope to transfer the gene which produces the collagenase protein capable of attacking and killing invading nematodes from the fungus to a crop plant.

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Chile and cotton producers in New Mexico commonly find their crops plagued by nematodes. Help is on the way from the scientists at NMSU's Plant Genetics Engineering Laboratory. Photo courtesy NMSU Agricultural Information.

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NM native named State Engineer



Photo by Ann Finley Wright, SEO

Cordova native Eluid Martinez took the office of State Engineer on December 12, 1990. As the *Albuquerque Journal* noted in a November editorial, "It's a daunting task" that Martinez faces, taking over a position "defined more by the 35-year tenure of the late Steve Reynolds than by state law or constitution."

Martinez will bring his own management style to the position. When asked how he would describe his management style, the new water boss replied, "I don't know if one word or phrase will do it. If employees do their job, I will give them the resources and flexibility they need." He has stated publicly that he would open up lines of communication to all water users in the state, to groups of water users with special concerns. He says that he already has had "more groups request my time than I can give in the next two or three months."

The current legislative session is challenging Martinez, too. He is facing discussion of the problems on the Pecos River and the El Paso and Canadian River lawsuits as well as internal agency concerns such as reorganization to better serve the public and obtaining a budget to enable the SEO to do its job. Martinez says he expects to spend a lot of time the next six months dealing with outside concerns to which the office should respond, then to begin looking at possible reorganization next summer.

"The organizational structure of this agency has not changed in some 30 years, and there are individuals who say the agency has not kept up with the times. I believe that perhaps some change is appropriate," he says. How that change will occur hasn't been determined, but the emphasis will be on better serving the public and better utilizing the agency's resources.

The state engineer maintains the agency will not take a pro or con position on any proposed legislation. "I view my role as pointing out the advantages or disadvantages of legislation that is introduced with respect to how it would impact the water laws and the use of water in New Mexico," he says.

As for discussion that perhaps it is time for New Mexico to replace the state engineer with a water board or committee, Martinez says, "I feel comfortable that, with the staff that exists in the State Engineer Office, one man can do the job."

WRRI report briefs

The following new reports are available from the New Mexico Water Resource Research Institute, Box 30001-Dept. 3167, Las Cruces, NM 88003 (505-646-1813) free of charge.

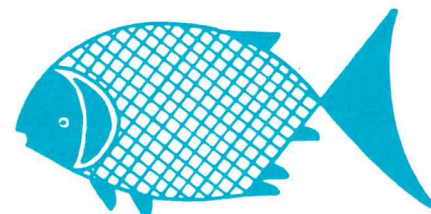
Report No. 251 - *New Approaches to Metal Speciation in Natural Waters Based on Modified and Microvoltammetric Electrodes* by Joseph Wang, August 1990.

This is a 15-page summary report of Wang's three-year project to produce more effective and reliable tools to analyze the presence, toxicity and transport of trace metals in natural waters. Wang, a professor of chemistry at New Mexico State University, confirmed the suitability and advantages of using ultramicroelectrodes to identify metal species in nonsaline waters. The report discusses stripping analysis, a relatively inexpensive technique which allows for the simultaneous measurement of four to six trace metals at concentration levels of parts per billion.

Report No. 252 - *User's Guide for Riofish: A Fishery Management Model for Large New Mexico Reservoirs* by Katherine Green-Hammond et al., and **Report No. 253 - *Riofish, a Fishery Management Planning Model for New Mexico Reservoirs*** by Richard A. Cole, et al., both published December 1990.

Funding for this extensive interdisciplinary project came from the Federal Aid in Fish Restoration Act,

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Options for delivering Pecos water to Texas are few

If current drought conditions persist, New Mexico could owe Texas Pecos River water again as early as 1992, unless steps are taken to increase the river's flow at the state line. There are two options available to do this--judicial and legislative--and according to the State Engineer Office, these are not mutually exclusive.

Employing judicial action, the SEO would use the prior appropriation system, shutting off as many junior water rights in the Pecos River Basin as necessary to deliver Texas its water. It would involve a state request for injunctions against all affected water-right owners and an opportunity for these owners to raise any defenses to having their water rights enjoined. If the defenses were denied, the court would issue orders shutting off water uses.

Because this option could involve terminating water rights for thousands of acres of land permanently and a large number of water rights for temporary, intermittent periods, the uncertainty of when and how shutoffs would occur could greatly disrupt the economy of the region and state. Therefore, State Engineer Eluid Martinez is seeking other solutions which require legislative action.

As directed by the 1990 Legislature, the SEO conducted a series of public meetings in the Pecos River Basin to present alternative solutions to determine what kinds of actions residents preferred.

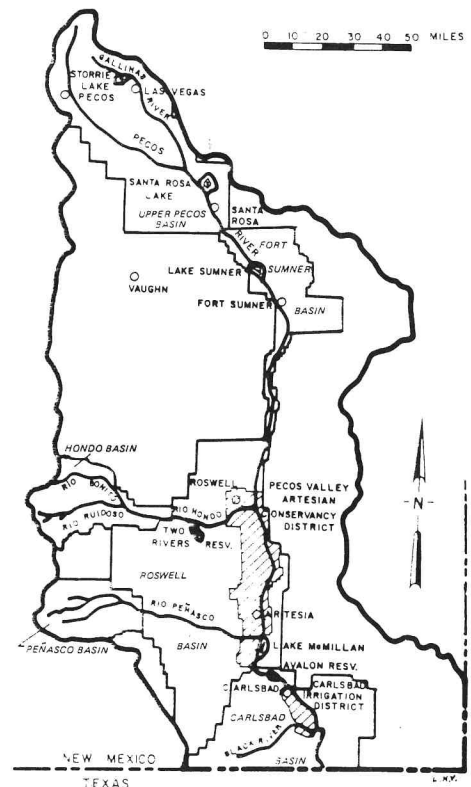
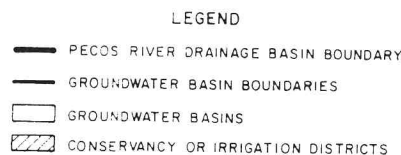
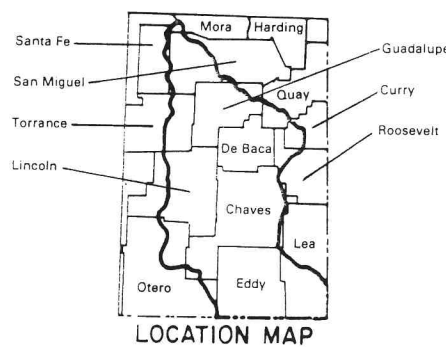
The broad range of solutions included developing well fields to pump ground water into the Pecos River, importing water from other basins, and retiring water rights through purchase or lease programs. The last measure was the one most

supported at public meetings, and was also recommended by the SEO to the legislature as the one which might be the least costly and least disruptive to the economy. Proposed legislative measures include:

- **Funds for water rights acquisitions** - An estimated \$60 million would be required for the temporary and permanent retirement of water rights in the Pecos River Basin.
- **Amendments to Water Right Forfeiture Law** - To facilitate the water rights retirement program, amendments to state law would be needed to assure the water rights which are retired are not forfeited for nonuse.
- **Water Rights Recording Act** - This proposed act establishes a method for recording changes in water right ownership through

county clerk offices, much as land ownership transfers are recorded. It would help protect water right purchasers and keep records current, allowing for more efficient water right adjudication and administration.

- **Anticipatory Curtailment of Water Use for Decree Compliance** - This would authorize the state engineer to shutoff water uses under the prior appropriation system prior to shortfall determination. The act assumes it's better to curtail fewer junior rights on a long-term basis in anticipation of shortfalls than to disrupt periodically virtually all uses on the Pecos River in reaction to an annual shortfall. The legislation would be used only if the state engineer believes a priority call is necessary.



THE PECOS RIVER BASIN

Source: *Pecos River Water Rights Adjudication, SEO, 1989*

Nematode-resistant crops (continued)

Sponsored by the Water Resources Research Institute and the U.S. Department of Agriculture, the project could benefit producers across the country. Thomas reports, "It's hard to find an agricultural area where there aren't nematodes on certain crops." He adds that

Many chemical options for nematode control have been axed due to potential ground-water contamination and soil residue problems.

many chemical options for nematode control have been axed due to potential ground-water contamination and soil residue problems.

The process to develop a nematode-resistant crop is quite long, however. First, the fungus is grown in the lab and the collagenase protein is purified. Using the protein as a "tag," the gene for collagenase will be isolated next. The next phase of the project involves transferring the collagenase gene to a crop plant and further testing to see if it expresses the collagenase.

In a related project, PGEL researchers are working on expressing human collagenase genes in plants. Kemp procured human collagenase clones from the Washington University Medical School in St. Louis. As a result, PGEL is home to the world's first tobacco plants transgenic with human collagenase. PGEL may even be the first to engineer a plant to express a human gene. Kemp says that within a few months they should be able to tell if the novel tobacco plants can produce the human collagenase. "We don't

know for a fact if human collagenase will digest nematode collagen, but their collagen is not all that different from human collagen," says Kemp.

Tobacco plants were used for these first tests because it is easy to introduce foreign genes into them. "Once we have demonstrated its effectiveness in tobacco, then we can go back and put it into agronomically important plants," Kemp explains. He reports alfalfa and cotton will most likely be the next plants to receive the genes.

Sengupta-Gopalan, Thomas, and Kemp are all enthusiastic about the genetic-engineering research at PGEL. Genetic engineering is a relatively young science--the first gene was transferred a decade ago.

PGEL may be the first to engineer a plant to express a human gene.

But as the science progresses, the work at PGEL will be accelerated. Kemp predicts a genetic-engineering revolution by the 21st century, although to date there isn't a genetically engineered crop in the field.

"You don't know what you'll discover," says Sengupta-Gopalan. And that excitement is what furthers progress in producing better plants. "The whole living world is our gene pool," says Kemp, "and crosses between organisms represent the power of the technology."

Magnets lure organics in wastewater

Discovered in 1983, sintered rare earth permanent magnets have become major components in many military and commercial electronic devices, particularly where small-size, high-energy density, and good resistance to demagnetization are required. Now researchers at Kyoto University in Japan have developed a water treatment system using the magnetic material as a finely divided powder. The system consists of the magnet powders mixed with bacteria and surrounded with polyacrylamide microbeads placed in a wastewater treatment tank.

The bacteria are able to live and reproduce in the polyacrylamide and break up organic materials in the wastewater. They are removed from the water using permanent magnets mounted on a rotating wheel, and then reused to treat more water. The British journal, *Engineer*, reports that when tested on solutions of organic compounds such as phenol, "the technique removed most of the organic material, compared with only 30 percent using conventional methods."

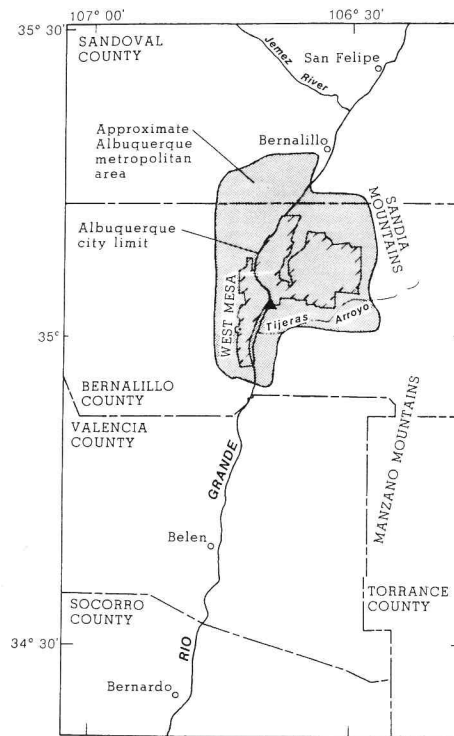
Collaborative drought study underway

Various southwestern institutions and organizations have joined forces for a study, *Coping with Severe Sustained Drought in the Southwestern United States*. Some of the participants include: Utah State University, Arizona State University, University of Arizona, University of California, University of Colorado Law School, and Metropolitan Water District of Southern California. The team will develop a plan for water management during widespread sustained drought.

Albuquerque infiltration, evaporation study available

Annual ground-water withdrawal from the Albuquerque metropolitan area more than tripled in 26 years, from 31,000 acre-feet in 1954 to 105,000 acre-feet in 1980, according to a recent US Geological Survey Report. Water levels in Albuquerque wells decreased 0.53 to 1.28 feet per year over the period of record tested. Despite this, it was found that water levels in shallow wells, 75 to 123 feet deep, close to the Rio Grande between Albuquerque and Bernardo increased 0.04 to 0.19 foot per year. From 1955 to 1984 streamflow losses on the Rio Grande between San Felipe and Bernardo decreased by 3,528 acre-feet per year.

Hydrologist Carole L. Goetz, principal author of the report, says, "The Albuquerque metropolitan area, located between these stations, may have contributed to this trend of reduced losses through increased runoff to the Rio Grande as a result of land-surface paving,



Location of Study Area

concrete lining of arroyos, and increased wastewater flow to the Rio Grande from the city's wastewater treatment plant."

Goetz and coauthor Shareen G. Shelton also found irrigated lawns had evapotranspiration rates three to five times that of native vegetation.

During the study, data collected at 17 sites from August 1983 through September 1986 included lithologic logs, neutron logs, net radiation, air and soil temperature, relative humidity, vapor pressure, soil moisture, soil-heat flux, hydraulic head, water level, precipitation, streamflow, and evapotranspiration rate.

Infiltration and Evapotranspiration within the Albuquerque, New Mexico Area with a Section on Historical Water-Resource Trends During the 1954-80's Period of Urban Growth may be ordered from Books and Open-File Reports, Federal Center Building 810, Box 25425, Denver, CO 80225 for \$15.50.

USDA announces pesticide database, water quality data center

The U.S. Department of Agriculture announced the availability of the first national computerized database with fully referenced lists of the physical and chemical properties of pesticides. With this information, USDA specialists will be able to assist farmers in managing pesticide applications under specific soil conditions to avoid causing water quality problems. Compiled by the USDA's Agricultural Research Service, the database consists of 16 chemical and physical properties of 92 widely used pesticides. Eventually it will be expanded to over 200 pesticides with 40 properties for

each. The database is available to researchers on diskette and will be available to farmers and ranchers from their local Soil Conservation Service offices in about six to twelve months. Inquiries may be directed to: Systems Research Laboratory, USDA, Agricultural Research Service, BARC, Bldg. 011A, Room 165B, Beltsville, MD 20705.

Another program being established by the USDA is the Water Quality Information Center at the National Agricultural Library. The center will respond to specific information inquiries, provide referrals to other agencies and organizations,

and facilitate communication among interested professionals, organizations and the general public. Information released on the new center states "WQIC is especially interested in developing innovative collaborations that will make water quality information more accessible." For more information, contact Janice C. Kemp, Coordinator, Water Quality Information Center, Room 1402, National Agricultural Library, Beltsville, MD 20705.

Research in the field

Getting down to the nuts and bolts of a project

Sometimes non-researchers don't appreciate all that goes on in the field where water-related studies are conducted. They're not out there

on the windy, dusty, 100° days, the cloudy, 30° days, or the days the generator fails. Below is a chronicle of what can go on in the field. This

is one day of field research for Tim Ward's and Susan Bolton's project, "Developing Parameter Values to
Continued on page 7



Top left - NMSU Engineer Susan Bolton is wrestling with the rainfall simulator on a windy day. **Top right** - Graduate student Saeed Jorat and Bolton are placing a curtain on the simulator. Due to the wind, this gigantic shower curtain is necessary to help confine the "rainfall" from the simulator to the plot being evaluated. **Bottom right** - Jorat is determining the rate of rainfall from the simulator. **Bottom left** - Professor Tim Ward is setting up a newly designed, more easily transported simulator. The research team will compare results from the new simulator to those from the older simulator. (Last three photographs by Charlene Keel, Alamogordo photographer and WRRRI student aide)

Upcoming meetings

- ◆ **Fifth National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods** - May 13-16, 1991, Las Vegas Nevada - Sponsored by the Association of Ground Water Scientists and Engineers, division of National Water Well Association. For more information contact, NWWA, 6375 Riverside Dr., Dublin, OH 43017 (614) 761-1711
- ◆ **Nonpoint Source Pollution: The Unfinished Agenda** - March 20-21, 1991, Tacoma, Washington - Presented by the water research centers and institutes for the states of Washington, Idaho, Alaska, Hawaii, and Oregon; sponsored by the US Geological Survey, EPA, USDA Soil Conservation Service, and others. For more information contact Diane Weber, Washington Water Research Center, (509) 335-5532.
- ◆ **The Fifth Symposium of Artificial Recharge of Groundwater** - May 29-31, 1991, Tucson, AZ. Sponsored by the Arizona Water Resources Research Center. For more information contact Susanna Eden, Water Resources Research Center, University of Arizona, 350 N. Campbell Ave., Tucson, AZ 85721, (602) 621-7607.

Nuts and bolts of research (continued)

Determine the Hydrologic Properties of Southwestern Soils," which uses rainfall simulators in data collection. Data gathered from the simulators is used to evaluate hydrologic and hydraulic characteristics of watersheds and certain soils.

How do the simulators work? Very simply, water is pumped from a portable storage tank to the simulator which rains on a selected plot with a trench adjacent to it. The trench serves as a collection trough. Initially, a metal plot cover is placed over the plot. The "rainfall" onto the plot cover is measured first. Then, the plot cover is removed so the rain can fall onto the plot, and the runoff can flow into the trough. The troughs are pumped at timed intervals so a volume of runoff is collected per a certain amount of time. Back in the laboratory, the runoff measurements and the runoff and its sediments are analyzed.

Acequia Association sponsors project

The Rio Chama Acequia Association, representing 21 acequias between Abiquiu Dam and Espanola, is undertaking a hydrological investigation of the lower Rio Chama Basin. It has hired geologist Bill Sayre, associate professor at Eckerd College in St. Petersburg, Florida to look at natural flow, water shortages and consumptive use.

Fred Vigil, chairman of the association, says the group plans to complete a report by mid-summer which would include the hydrological investigation as well as an archaeological and historical summary. He adds that the study is an offshoot of the adjudication process which has been ongoing since the 1960s.

Report briefs (continued)

WRRI, and the Agricultural Experiment Station. RIOFISH is a comprehensive sportfishery planning model that simulates a fishery planning system including procedural inputs, the socioeconomic system, and outputs pertaining to fishing opportunity and angler benefit. It can be used to forecast resource and angler response to management strategies applied in different possible planning environments. RIOFISH can be used also to facilitate decisions based on anticipated angler benefit and agency management cost.

Report No. 254 - Regenerative Properties of Spent Tailored Soils by Fernando Cadena and Enrique Cazares, December 1990.

This was a follow-up to Cadena's project, "Treatment of Water Supplies Contaminated with Toxic Pollutants Using Tailored Soils," completed in 1988. It looked at the adsorption capacity of tailored soils (Wyoming bentonite, Glendale clay-loam, and a clay-loam soil from Los Angeles) used to remove organic pollutants from contaminated water after it had been used and regenerated through a drying process. They found that low temperatures and short drying times permit almost total volatilization of benzene and toluene from spent soils for further adsorption of these contaminants.

Miscellaneous Report M23 - New Mexico State Land Trust Assessment: 1990, edited by Tom Bahr, et al., December 1990.

This report is an evaluation of the state's land trust assets by an assessment team selected primarily from state universities and coordinated by WRRI. It provides an historical overview of the trust and an analysis of its resources and future issues which could affect the trust's income.

More restrictive regulations, public fear dominate environmental law trends

Attorney Joe G. Moore, Jr. who serves as a senior technical consultant with BCM Engineers in Dallas, Texas, was the keynote speaker for the 35th Annual New Mexico Water Conference held in Albuquerque November 15-16. Moore, who taught in the graduate program in Environmental Sciences at the University of Texas at Dallas for over a decade, discussed trends in environmental laws.

Moore believes that the 1990s will bring the following:

- Environmental regulations will continue to become more restrictive and more specific to respond to public demand. Numerical limits on permissible discharges and emissions of pollutants will become lower and cover more pollutants.
- Public fears rather than scientific certainty will dominate new areas of regulation and general legislation. Regulations will narrow the discretion of governmental administrators and the range of compliance choices available to regulated groups.
- The number of effluent limits on discharges from publicly owned treatment works will be expanded to include any chemical or substance of concern for the protection of fish, shellfish and wildlife that may reach an individual treatment plant from household wastewater, industrial discharges subject to pretreatment effluent limits, and storm-water infiltration or runoff.
- The use of calculated effluent limits derived from state-adopted water-quality standards, including those derived from state compliance with the Environmental Protection Agency's published strategy for storm-water control and treatment, will increase significantly. According to Moore, such an approach avoids the procedural due process required for the "best practicable control technology currently available" (BPT), "best conventional pollutant control technology" (BPCT) and "best available technology economically achievable" (BAT) prescribed by the Clean Water Act.
- Superfund sites on the National Priority List will continue to contaminate ground water, and maybe surface water also, far into the 21st century because of the large number of sites (nearly 1200), the procedures being followed to select the remediation method and the substantial per site costs being incurred.
- Due to fears of ground-water contamination, landfilling of hazardous waste will be terminated. Incineration at sites remote from population centers or in floating incinerators at some distance offshore are the most likely substitutions for landfilling.

Tom Bahr, Director, New Mexico Water Resources Research Institute
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