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OKLAHOMA water news

MONTHLY NEWSLETTER OF THE OKLAHOMA WATER RESOURCES BOARD

OSU Scientist Uses Fireflies, Cancer Cells to Detect Pollution

Two things could hardly be more dissimilar.

One is the firefly. Elusive and enchanting, fireflies have charmed generations of children. Their capture is a thrilling activity—energy and joy loosed on a warm summer evening.

The other is the human cancer cell. Dreaded and dangerous, the cancer cell is known as a harbinger of death. Dividing without control, they invade and destroy surrounding tissue.

Future needs for more and better methods of water testing have brought both the firefly and the cancer cell to the forefront of scientific research at Oklahoma State University, where biochemistry professor Franklin Leach is using them to detect bacteria and toxic substances in water.

It is the luminous quality of the firefly that has Leach glowing. Fireflies flash their signals to attract mates, he explains. The flash is made with the aid of a compound called luciferin and an enzyme that breaks it down, called luciferase. In the presence of a compound called adenosine triphosphate (ATP), a chemical reaction gives off light.

PHOTO BY FRED CAUSLEY, PUBLIC INFORMATION, OSU

OSU biochemistry research associates Steve Van Doren and Marliese Hall prepare a culture of human cancer cells which will be used in a new method to test water for toxic substances.

ATP is an energy-storing molecule, a charged battery that exists in all living organisms, including dangerous bacteria that pollute water. When ground-up firefly tails are exposed to the ATP present in polluting bacteria, light is emitted. The amount of light indicates the pollution level and can be measured by a special instrument, the ATP photometer.

Leach notes that the new test is valuable because normal water quality tests don't detect the presence of many types of dangerous bacteria.

"Of couse, there are normal background populations of helpful bacteria that also contain ATP in their makeup. When the photometer sees an excessive amount of light, we know that harmful bacteria have entered the water and found it hospitable. It's like raising a flag to let us know they are there," Leach says.

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Board Program Sets Standards of Performance for 155 Labs

April 29 was the cutoff date for 113 Oklahoma laboratories and 42 of their out-of-state counterparts to have completed analyses of "spiked" water samples as part of a continuing Oklahoma Water Resources Board certification program that helps maintain clean state waters, says OWRB Executive Director James R. Barnett.

The program is laboratory certification (Lab-Cert), designed to provide reasonable assurance that measurements of minerals, nutrients, metals, toxic substances and other contaminants in water are accurate.

How does the program help keep state waters in good shape? State water quality standards provide that no waste can be discharged into any waters of the state without first being treated to protect the uses a given stream may serve. For instance, if a stream is used for municipal water supply, the OWRB may require that all discharges of copper upstream cannot result in a total of more than one milligram per litre at the point the city diverts the water.

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Board Program, continued from page 1

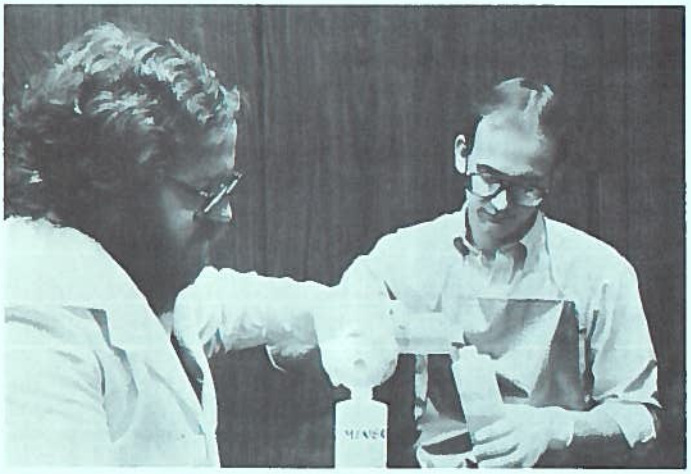
At the end of every quarter, each of some 400 industries discharging wastes into state rivers and streams must file a report with the Board noting the level of contamination of their discharge water. To guarantee the report's reliability, a lab certified by the OWRB to test for the contaminants listed on each industry's permit must be used to analyze the water.

Lab-Cert tests are conducted twice a year, according to Senior Envionmental Engineer Gene Chou, who heads the program. Labs that want to be included in the testing make their requests in March and September. In early April and October, water quality personnel prepare reference samples for the labs, adding minerals, nutrients, metals and toxics to water and circulating the solution through sets of 13-gallon bottles to assure a uniform mix. This year, 580 pint bottles were filled with the loaded water and packed into 158 parcels before shipment to the labs.

Results of the water analyses must be returned by the labs to the OWRB within four weeks. Within two weeks after the cutoff date for receiving analyses results, the OWRB sends out a statistical report detailing the performance of every lab tested.

The laboratories measure concentrations of contaminants in milligrams per litre, the rough equivalent of parts per million–microscopic specks in even a pint container of water. Dr. Wayne Pettyjohn, Geology department head at Oklahoma State University, has noted that one part per million is comparable to one cent in ten thousand dollars or one minute in two years. At the same proportions, Pettyjohn says, one could make a very large, dry martini by mixing one ounce of vermouth into an 8,000 gallon tank car of gin.

With distinctions so fine, different labs measuring the same water detect minutely different concentrations of contaminants. The OWRB certifies laboratories that report analyses within a reasonable range of accurate answers as determined by group statistics during each test.



STAFF PHOTO BY BARRY FOGERTY

Brooks Kirlin, left, and Mike Nash of the Board's Water Quality Division prepare reference samples for distribution to labs seeking certification.

With labs in 11 states other than Oklahoma asking to be included in the program, it's apparent that something is being done right.

Part of it is the cost. The first set of reference samples from the OWRB costs just $30, with bottles thereafter only $5 apiece. Chemical suppliers charge as much as $75 a set for similar samples.

It's also a way for a lab to assure its own quality.

"Some of the labs in the program aren't involved in analyzing industrial discharge water for Oklahoma, but participate solely as a means of checking their own accuracy," Chou explains.

Certification also requires participating labs to employ full-time someone with a bachelor's degree in chemistry or a closely related field. Each year the labs must bring the Board up-to-date on personnel and equipment changes, and records of all analyses must be maintained for a minimum of three years.

"Most other states with laboratory certification programs simply certify after an on-paper evaluation, finding out if the labs have the equipment and personnel they need to do the studies. Our program is more sophisticated in that we provide reference samples and establish numerical limits that the laboratories' analyses must match in order to be certified.

"Oklahoma's future is highly dependent upon the quality of water it has available, and this program helps us preserve it," Chou concludes.

Fireflies, continued from page 1

Specific assays follow to identify the harmful bacteria versus normal bacteria.

"Tests conducted now are good enough to keep us healthy on a normal basis, but they aren't very quick. As our technology and populations increase in the future, we will have to reuse water in shorter periods," Leach says.

Cancer cells similarly raise a flag when toxic substances are in water.

"This test will not tell us what dangerous contaminants may be in a given sample of water, but it tells us something is there, and that it is not good for living organisms," the biochemist says.

The feature that makes cancer cells so inherently dangerous—an ability to rapidly reproduce—makes them good subjects for water toxicity testing.

The researchers employ tiny glass beads, called microcarriers, to handle the cancer cells. The cells adhere to the beads, which offer just enough surface area for a population of about 100,000. A radioactive tracer element added to the culture in which the cells are raised allows scientists to count the population by measuring radioactivity. A sudden decrease in the population of cells introduced into a sample means something in the water is killing them.

"Our goal was to shorten the time it takes to get a

preliminary indication of something toxic being in the water from any source," Leach says.

He points out that current methods of water toxicity testing are slower and less accurate. One commonly used method is to put 20 or so minnows in a tank of three to five gallons of the water in question.

Observations of the minnows are conducted at 24, 48 and 96 hours to see if any of the fish die. If the fish don't die and the substance sought is important enough, they are dissected and analyzed to see if their body tissues contain the compound.

By contrast, an entire population of cancer cells can turn over in a 20-hour period. Further, Leach's test can be conducted using only a few drops of water containing a populaton of 100,000 subjects—the cancer cells. Statistically, the findings from that large a population are much more meaningful than from 20 individuals, regardless of size.

Will the new tests ever be widely used? It appears so. Firefly bioluminescence — ATP assays have been studied as a method for rapidly detecting and counting microorganisms in breweries, and NASA has used the ATP test to monitor bacterial buildup in the water supplies of astronauts.

Leach says both the firefly test for bacteria and the cancer cell test for toxics are faster than tests being used now. Further adaptation of the techniques is up to society, he concludes.

Fear Tested as a Persuader in Reducing Farm Water Use

How does fear influence a person's behavior? Three professors at Oklahoma State University are attempting to find out in a study designed to measure the effectiveness of fear appeals in promoting agricultural water conservation.

"During normal times, most people view water as an abundant and essentially free good. With the continued availability of water becoming a critical problem, it's important that the public be aware of the problem and persuaded to conserve," says James Gentry, who along with Charles Robertson and Thomas Tice, is releasing the results of the study funded by the University Center for Water Research at OSU.

The idea of fear as a method of persuasion certainly isn't new. Gentry's background in "decision theory" led to his interest, and he points to a number of advertising campaigns that use fear as a central motivation. Insurance companies sometimes play on the fear that a loved one may die suddenly. Classics in fear appeal, Gentry believes, are some of the anti-smoking commercials, seatbelt commercials and driver education films.

Finding a motivation to conserve in the agricultural community is important because it is irrigation that uses approximately 80 percent of Oklahoma's water.

"The agricultural sector is an intriguing area because it appears that short-run costs of conservation outweigh short-run benefits. There is really no reason or motivation for the individual to conserve although collectively it would benefit society."

To find out if irrigators could be persuaded by low, moderate or strong fear appeals, researchers used a com-

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ACTIVE CONSERVATION STORAGE IN SELECTED OKLAHOMA LAKES AND RESERVOIRS AS OF APRIL 18, 1983

PLANNING REGION LAKE/RESERVOIR	CONSERVATION STORAGE (AF)	PERCENT OF CAPACITY
SOUTHEAST		
Atoka	113,700	91.6
Broken Bow	894,200	97.4
Pine Creek	69,000	88.8
Hugo	157,600	100.0
CENTRAL		
Thunderbird	105,000	99.9
Hefner	70,400	93.4
Overholser	15,400	96.6
Draper	78,700	78.7
SOUTH CENTRAL		
Arbuckle	62,600	100.0
Texoma	2,618,800	99.3
Waurika	203,100	100.0
SOUTHWEST		
Altus	93,900	70.7
Fort Cobb	76,200	97.1
Foss	154,900	63.5[2]
Tom Steed	75,200	84.6
EAST CENTRAL		
Eufaula	2,329,700	100.0
Tenkiller	627,500	100.0
Wister	27,100	100.0
Sardis	197,300	65.2[1]
NORTHEAST		
Eucha	79,800	100.0
Grand	1,491,800	100.0
Oologah	544,300	100.0
Hulah	30,600	100.0
Fort Gibson	365,200	100.0
Heyburn	6,600	100.0
Birch	19,200	100.0
Hudson	200,300	100.0
Spavinaw	30,000	100.0
Copan	38,900	89.6[1]
NORTH CENTRAL		
Kaw	428,600	100.0
Keystone	616,000	100.0
NORTHWEST		
Canton	97,500	100.0
Optima	1,900	—[1]
Fort Supply	13,900	100.0
Great Salt Plains	31,400	100.0
STATE TOTALS	**11,964,400**[3]	**97.2**[3]

1. In initial filling stage
2. Temporarily lowered for maintenance
3. Conservation storage for Lake Optima not included in state total

Data courtesy of U.S. Army Corps of Engineers, Bureau of Reclamation, Oklahoma City Water Resources Department, and City of Tulsa Water Superintendent's Office.

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puterized farm management simulation game involving more than 200 junior-level agricultural economics students in two semesters. Each student was put in charge of a 1600-acre irrigated farm and allowed to grow alfalfa, corn, cotton, milo and wheat. Budgets were set out for each crop, and yields and prices were the same for all participants.

Since measuring actual water conservation in the field would have taken too long, students packed six years of farming into two weeks, each week representing a 3-year period. At the beginning of the second week, students were exposed to the fear appeals.

Researchers were testing two hypotheses. The first was that change in attitudes, behavior and intention would increase as the probability of peril increased. Sets of students were alerted to the 10 percent, 50 percent and 90 percent probabilities of serious water problems in the near future.

The second hypothesis was that change in attitude, intention and behavior would increase as consequences of no action increased. Students were told that falling ground water levels would increase irrigation pumping costs 15 percent, 45 percent and 75 percent.

After exposure to the fear appeal, students were asked to make a decision, either by doing nothing or choosing one of four improvements to their irrigation systems.

Although many students did purchase new irrigation equipment, on the whole, little support was found for either hypothesis. Evidence did indicate that the students responded better to moderate fear appeals than strong ones, perhaps because the higher levels of fear arousal caused participants to deny the problem altogether.

With modifications, the game will probably be used again in the future.

Research Papers Sought by SMU

An interdisciplinary conference on municipal, industrial and agricultural water supply problems of the Southwest United States will be held on the campus of Southern Methodist University April 3-5, 1984. With the conference focusing on constraints, realities and alternatives the region faces in meeting water needs, papers are being sought in the broad areas of technological alternatives, engineering planning and management, resource utilization and conservation, economics, law and technology transfers as they relate to water supply in arid and semiarid regions.

Abstracts are due by August 15, 1983. For information, contact Conference Chairman Michael A. Collins, School of Engineering and Applied Science, Southern Methodist University, Dallas, Texas, 75275.

APRIL CROP AND WEATHER SUMMARY

Growth of spring crops was hampered by abnormally cold weather and overcast skies across much of the state in April. Wheat, oats and barley were in generally good condition, and row crop activity remained slow. Alfalfa and livestock forage were also limited in growth.

Rainfall in April ranged from an accumulation of 4.78 inches in the northeast to 1.03 inches in the Panhandle. Subsoil moisture supplies were adequate to surplus. Temperatures ranged from six degrees below normal in the Panhandle at month's end to 19 degrees below normal in north central areas at mid-month.

Oklahoma Crop and Livestock Reporting Service

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