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Water Crisis--An Approach for Teachers of Grades 7-12

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Table 1. UVR of gamma ray-induced chromosomal aberrations in G1 phase A8W4 cells as a function of UV dose. In each experiment synchronous cultures were exposed to the indicated doses of UV, one hour after mitotic selection, and 200 rads gamma ray was administered immediately after the UV exposure.

Experiment number	UV dose in ergs/mm^2	Collection time range (hours after mitotic selection)*	Number cells scored	Chromatid type aberrations		Chromosome type aberrations		
				Terminal deletions	Exchanges	Terminal deletions	Rings	Dicentrics
1	0	22-32	200	1	0	51	17	23
2	10	24-34	200	2	0	52	18	21
3	20	30-40	200	0	1	51	16	22
4	30	42-52	200	1	0	53	16	21
5	40	45-58	200	1	0	62	14	19
6	50	48-60	200	2	0	68	11	18
7	60	50-62	200	1	0	79	11	15
8	80	55-70	200	2	1	83	9	15

*Cells were collected for aberrational analysis by colcemid treatments that spanned the indicated time range.

Table 2. Time course of UVR of gamma ray-induced chromosome-type aberrations in A8W4 cells. In each experiment, a synchronous cultures of G1 phase cells was first exposed to 200 rads gamma ray (one hour after mitotic selection) and then exposed to 80 ergs/mm^2 UV, with the UV exposure beginning at the indicated time following termination of the gamma ray exposure.

Experiment number	UV dose (minutes after gamma ray exposure)	Collection time range (hours after mitotic selection)	Number cells scored	Chromosome type aberrations		
				Terminal deletions	Rings	Dicentrics
1	0	55-70	200	80	6	13
2	5	55-70	200	78	8	12
3	10	55-70	200	79	7	14
4	15	55-70	200	76	6	12
5	25	55-70	200	62	12	15
6	45	55-70	200	49	15	23
7	90	55-70	200	50	17	24

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THE WATER CRISIS — AN APPROACH FOR TEACHERS OF GRADES 7-12

The development of a water-ecology workshop has resulted from the confluence of three observations. First, several recent events attest a growing concern for the quantity and quality of Arkansas' water. In 1981 Governor Frank White appointed a committee to develop a comprehensive water code. The committee's work culminated in the presentation of House Bill 60 and Senate Bill 8 during the 1983 legislative session. During 1982 the Winthrop Rockefeller Foundation founded a public-awareness project, entitled "Arkansas Water: Why Wait for the Crisis?", which has received wide dissemination. Also during 1982 the Arkansas Department of Pollution Control and Ecology received a National Science Foundation grant to fund a scientific policy review for that agency, particularly with respect to improving stream classification, lake management, and hazardous waste disposal. Secondly, it is my experience that the older an individual becomes, the more difficult it is to modify his/her behavior, especially with regard to the environment. Finally, teachers of secondary education need inexpensive resource materials and teaching techniques that will allow them to instruct science in today's world. Accordingly, the purposes of this workshop are to provide teachers with: 1) a broad overview of the interrelationships of water and man; and 2) at least one functional freshwater-ecology unit for classroom use.

In order to serve the maximum number of teachers, the workshop is numbered to provide three semester hours of credit for either upper-level undergraduate or graduate students. Each student is required to participate in class activities, construct a teaching aid (e.g. a sampling device), and develop one water-ecology teaching unit. The teaching unit may emphasize class or field work, or a combination, depending on the constraints of that student in the school where he/she teaches. Additionally, individuals taking the workshop for graduate credit research and develop a report on a particular water use outside the workshop syllabus.

The lecture portion of this workshop is designed to acquaint teachers with the importance of water. A basic ecology unit is followed by units emphasizing water use in agricultural, industrial, recreational and municipal/domestic applications. In each of the latter units the student learns how the water is used, in what quantities, how water quality is affected by that use and what the future prospects are.

The laboratory periods are utilized for a variety of activities. Field trips are made to local streams and the sewage-treatment facility. Students become familiar with plans for constructing inexpensive water-related sampling devices and construct at least one such device. Discussion periods are held during which the students exchange information concerning environmental teaching techniques and activities with which they have had success. A resource room is utilized which has been well provisioned with water-related information. Ideas for science fair projects are developed. Ultimately, these resources are synthesized as each student develops at least one complete freshwater-ecology unit specifically designed for his/her classroom situation.

One example of a free sampling method is effective observation. It is also informative and has wide application. Observations may include the variety of aquatic life, behavior, water turbidity and substrate type. Organisms can be returned to the classroom aquarium for further observation (e.g. air bubble respiration in aquatic beetles). Measuring current speed and volume flow can also be done without expense (Phillips, R. E., Jr. 1984. A field trip to the stream. Carolina Tips. 47[2]:5-6). A thermometer, tea strainer, aquarium dip net and minnow seine bring studies of habitat requirements, species diversity and numerical standing crops within one's capabilities for little expense.

Among the information resources utilized, I have found four to be particularly u eful in providing ideas and techniques (U.S. Environmental Protection Agency. 1974. Environmental exchange — a beginning. President's Environmental Merit Awards Program, USEPA, Washington, D.C. 21 pp.; Resh, V. H., and D. M. Rosenberg. 1979. Innovative teaching in aquatic entomology. Canadian Spec. Pub. Fish. Aq. Sci. 43. 118 pp; Miller, G. T., Jr. 1982. Living in the environment. Wadsworth Publ. Co., Belmont, CA. 671 pp; and Disinger, J. F. 1983. Learning *in* the environment. Env. Ed. Fact Sheet. No. 2. ERIC Clearinghouse for science, mathematics, and env. ed. Columbus, OH. 2 pp.). The last three contain extensive bibliographies.

Characteristically, teachers have every intention of incorporating new knowledge from their summer courses into their teaching curriculum. However, too much work and too little time often combine to thwart even the most conscientious teachers. The major strength of this workshop lies in its ensuring that each teacher takes a complete water-ecology unit, tailored to his/her specific needs, including budgetary constraints, back to the classroom. This maximizes the probability that this environmental education will be transmitted to the secondary level, where it is sorely needed.

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PROTECTION OF ENDANGERED GRAY BAT *(Myotis grisescens)* COLONIES IN ARKANSAS

The gray bat, *Myotis grisescens,* is one of three Arkansas bat taxa listed as endangered (in danger of extinction throughout all or a significant portion of their range) by both the U.S. Fish and Wildlife Service and the Arkansas Game and Fish Commission. Other Arkansas bats listed as endangered are the Indiana bat, *Myotis sodalis,* and the Ozark big-eared bat, *Plecotus townsendii ingens.*

Gray bats, unlike most bat species, are cave residents throughout the year, although different caves are usually occupied during summer than in winter; few have been found roosting outside caves (Barbour and Davis, 1969). They hibernate primarily in deep vertical caves with large rooms that act as cold air traps. They form tight clusters of up to several thousand individuals and choose hibernation sites where temperatures average 6-11 C (Barbour and Davis, 1969). During summer, female gray bats form maternity colonies of a few hundred to many thousands of individuals. Maternity colonies prefer caves that, because of their configuration, trap warm air (usually 14-25 C) or that provide restricted rooms or domed ceilings that are capable of trapping the combined body heat from clustered individuals (Tuttle, 1975; Tuttle and Stevenson, 1978). Maternity caves are rarely located more than 2 km, and usually less than 1 km, from rivers or reservoirs.

During spring and autumn transient periods, gray bats occupy a wider variety of caves. During all seasons, males and yearling females seem less restricted to specific cave and roost types. Because of their highly specific habitat requirements, fewer than 5% of available caves are suitable for occupation by gray bats (Tuttle, 1979).

Gray bats forage primarily over water along rivers or near lake shores. Most foraging occurs within 5 m of the surface. Mayflies are apparently a major item in their diet.

Approximately 250,000 gray bats hibernate in only four Arkansas caves, over 99% of these in a single Baxter County cave. During summer, ca. 150,000 gray bats occupy 40 caves scattered throughout the Arkansas Ozarks. Approximately 100,000 migrate to summer colony caves in Missouri, Oklahoma, and Kansas. Ten maternity colonies are known in Arkansas, nine of which are on private lands.

A major factor in the decline of gray bat populations has been human disturbance to gray bat colonies in caves. Hibernating gray bats, when disturbed by humans entering their hibernation caves, arouse, using up previous fat needed to survive the winter. If disturbed more than a very few times, they may starve to death before insects become available in the spring.

Maternity colonies are very intolerant of disturbance, especially when nonvolant young are present. If disturbed, baby bats may be dropped to their deaths or abandoned by panicked parents. The protection of gray bat caves from human disturbance is of foremost importance in the survival of this extremely beneficial bat species.